MEETING THE CHALLENGE:
U.S. INDUSTRY FACES THE 21ST CENTURY

THE U.S. ENVIRONMENTAL INDUSTRY

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TABLE OF CONTENTS

FOREWORD

The ability of the United States to achieve sustained and sustainable economic growth is directly linked to the opportunity for its businesses to integrate environmental and productivity decisions. Since 1970, successive Congresses and Presidents, in a bipartisan response, have introduced a wide range of policies and programs directed toward improving U.S. environmental performance. These policies and programs have led to substantial environmental improvements across the United States. More recently, market-based, information-based, and performance-based policy instruments have begun to be introduced; these new policy instruments encourage the marketplace to seek and apply environmental solutions both to enhance economic competitiveness and to improve environmental parameters.

"Meeting the Challenge: U.S. Industry Faces the 21st Century" is a series of reports produced by the Office of Technology Policy to assess the competitive position of important U.S. industries and the factors affecting their growth. While the reports are based primarily upon the experiences of the private sector, both academic and government organizations have contributed to the series. In this study, more than 100 executives of environmental companies and dozens of their customers, regulators, and financiers have directly contributed their experience and insights to the first comprehensive study of the U.S. environmental industry, suggesting a framework for government policy that explicitly reflects their concerns and perspectives. As in all of these reports, the views expressed are those of the authors and reviewers, based upon their industry research, and not necessarily those of the Department of Commerce.

Several valuable insights emerge from the study. One is that the environmental industry faces competitive challenges that have been widely unrecognized, particularly in Washington, DC. Another is that the government policies that produced significant environmental gains in the past are now at the point that many industry spokespersons believe fundamental changes are necessary, both for the sake of the environmental goals they seek to achieve and the industry that helps achieve those goals. These changes can create "win-win" opportunities for the American economy and the environment. On a related note, the report makes clear that both the environmental industry and the government will need to work more effectively individually and together on behalf of exports of environmental products and services.

OFFICE OF TECHNOLOGY POLICY

An Executive Summary of this study has been published separately. Copies of both this study and its Executive Summary may be obtained from the publication request line of the Office of Technology Policy (202-482-3037) or from the Office's web site at http://www.ta.doc.gov/reports.

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We would also like to thank the many other people who contributed to the success of this study. In particular, we want to note contributions by Jane Ginn, President of Ginn & Associates, Inc.; Walter Howes, President of EBI Financial, Inc.; and Frank Pope, Managing Director, Verdigris Capital. Ms. Ginn contributed to the export sections of the study and Mr. Howes contributed to the finance sections. Frank Pope contributed to the content of the report on the capital structure of the industry.

As part of the fact-finding process leading to the publication of this study, the authors met with many leaders of the environmental industry who willingly offered their experience and knowledge. The study was further improved as a result of comments offered to us by officers and executive directors of more than a dozen environmental business groups during several presentations of the draft. In addition, a number of industry representatives and observers participated in meetings at the Department of Commerce to discuss the report and its content. Participants in these review meetings, which were chaired by Graham Mitchell, then Assistant Secretary for Technology Policy, and Kelly Carnes, Deputy Assistant Secretary for Technology Policy, included the following:

Ira Rubinstein and Joanne Wortman, *Environmental Business Association of New York State*
John Schofield and Brian Runkel, *California Environmental Business Council*
John Mizroch, *Environmental Export Council*
David Welsh, *Northwest Business Council*
William Wallace, *Colorado Environmental Business Alliance and the Hazardous Waste Action Coalition*
Nikki Maloney, *Colorado Environmental Business Alliance*
Duane Truitt, *Southern Environmental Business Council*
Betty Deiner, *Environmental Business Council of New England*

Robert Prince, *GTS Duratek Inc.*
Tim Ogburn, *California Trade & Commerce Agency and Environmental Industry Coalition*
John Cusack, *Law Environmental Services, Inc.*

Other reviewers included:
Robert Hurley, *Pittsburgh High Technology Council*
Brent Temmer, *Colorado Environmental Business Alliance*
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Jackie Sellers, *Georgia Environmental Technology Consortium*
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Susan Resetar, *RAND Corporation*
Stanley Chanesman, *Department of Commerce*
Eric Fredell, *Department of Commerce*

Both the Office of Technology Policy and the authors gratefully acknowledge the participation and contribution of these individuals and their organizations.

1. The U.S. Environmental Industry

This chapter describes the environmental industry in the United States. It benchmarks the industry's size and performance as an important contributor to the U.S. economy, and examines the industry's current competitiveness in delivering value to its customers in the public and private sectors. The industry is discussed in traditional economic terms of employment, revenue generation, exports, and return on investment, as well as in terms of its social value to the public.

The process of applying engineering and technology for the improvement of environmental quality dates back well into the history of civilization. Organized societies have long developed technology, systems, and services to provide water and manage waste. Performing these functions for commercial gain, however, and quantitatively measuring revenues generated from these and related environmental commercial endeavors, hardly dates back 25 years.

The process of applying engineering and technology for the improvement of environmental quality dates back well into the history of civilization.

The reason for this discrepancy traces back to the historical treatment of the environment as a "free good" in economic terms. The environment is something that is not "paid for." It is merely consumed with no economic consequence; one person's breathing of the air has no apparent effect on another's ability to breathe the air, for example. Yet in the past century, humankind has so increased its population and its ability to consume and concentrate resources that the economic consequences of environmental degradation and unsustainable resource consumption have become dangerously apparent.

The industrial revolution and the technology explosion of the 20th century led to great improvements in quality of life for Americans. However, the long-term negative effect of these developments on our environment and natural resources has not yet been calculated. This tension between our material progress and its environmental consequences must be rationally addressed if we are to structure environmental and economic policies in the increasingly global, free-market economy.

This fundamental policy challenge must also be addressed in the short term to sustain environmental progress and the industry that enables this progress. The ongoing and sometimes dramatic consequences of environmental degradation from technological, economic, and population growth pushed limits to such an extent that public outcry led to the institution of environmental regulatory policy. This regulatory frame-

work created the environmental industry of today that largely manages pollution *after* it has been created, through waste management, pollution control, and site cleanup.

The U.S. environmental industry grew to significant size in this regulatory era. In 1996, the industry employed 1.3 million Americans, generated $181 billion in revenues, and contributed $16 billion to U.S. exports. But its growth has been curtailed dramatically as the effectiveness of regulation-based policy has passed a point of diminishing returns. Industry leaders believe that both they and their customers will benefit from a new economic framework for environmental policy that creates a climate of demand for continuous environmental improvement in resource, manufacturing, and service industries, as well as in government and the public at large.

1.1 History of the Industry

Although the environmental industry is often referred to as an emerging sector, it has its roots in water delivery (going back to the aqueducts of Rome), sanitation engineering (sewage infrastructure, as in the ancient city of Ephesus), and waste management (early refuse collection, evidenced even in Native American settlements). In other words, this base in environmental infrastructure is certainly not new, but the inclusion of newer segments, new technologies, and new policy is still taking shape and will continue to do so.

This base in environmental infrastructure is certainly not new, but the inclusion of newer segments, new technologies, and new policy is still taking shape and will continue to do so.

The environmental industry in the United States began with municipal management of water systems, sanitary engineering, and waste collection in the 1800s. The main impetus for these functions was the need for basic environmental infrastructure and a growing popular demand for the protection of public health. In 1970, the Environmental Protection Agency (EPA) and the Council for Environmental Quality were born. They were initially the acting arms of the National Environmental Policy Act. Soon after, the environmental industry gained new impetus and coherence as the passage of clean air and water pollution control acts stimulated demand for new types of products and services. New breeds of private business activity emerged, such as air pollution control equipment, environmental consulting and engineering services, sophisticated environmental instrumentation and testing services, hazardous waste management, and remediation services.

During this formative era, environmental priorities tended to be problems the public could see, smell, and touch—such as dumps, raw sewage, and industrial air pollution. Solutions to these problems usually involved large capital projects and central public-sector involvement. Large-scale systems were designed and built to manage ongoing waste streams, and control devices were mandated and then designed to minimize the effect of air and water pollution on the environment. These devices were manufactured by a growing list of private companies.

In the 1980s, landmark U.S. legislation in the form of the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Resource Compensation and Liability Act (CERCLA) launched a new era of environmental policy development focused on sometimes unseen toxic and hazardous waste. Amendments to the clean air and water laws expanded the breadth of their coverage. Policies and regulations under these new laws attempted to impose a "polluter pays" approach by assigning a clearer chain of liability for pollution and contamination. These laws, policies, and regulations employed a punitive, "command and control" apparatus administered primarily by EPA and state agencies.[1] Rather than creating more public-sector infrastructure, this system depended on private-sector industries to provide the products and services needed for regulatory compliance. This stimulated tremendous growth in the demand for environmental products and services, and more revenues for the emerging environmental industry, as companies sought to avoid fines, shutdowns, and the wrath of environmentally sensitive consumers and public officials.

Environmental protection was largely positioned as a cost item for industrial polluters, and government and the environmental interest community paid little attention to the long-term consequences of that approach. Environmental expenditures were seen by business as a necessary evil, rather than as a potential "win-win" factor in economic and business terms. The rush of new legislation in the end of the 1970s and in the 1980s led to a strong buildup of antiregulatory rhetoric in the industrial community and a growing cry of "unfunded mandates" by

Environmental protection was largely positioned as a cost item for industrial polluters, and government and the environmental interest community paid little attention to the long-term consequences of that approach.

[1] The term "command and control" has been widely used for many years. For example, U.S. Congress, Office of Technology Assessment, *Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities*, Washington, DC, January 1994, page 263: "Emphasis remains on treating pollution once it has been released (end-of-pipe approach) rather than on preventing it. A single media approach to pollution predominates with separate laws, regulatory offices and enforcement procedures for air, water, hazardous waste, and other media."

local governments across the country. By the end of the 1980s, this backlash resulted in a slowdown in the issuance of new regulations and some softer enforcement. Nevertheless, the volume of backlogged work was sufficient to tax the capacity of environmental service firms, many of which still doubled in size annually.

For pollution control equipment firms, the conflicting trends of new legislation and apparently reduced will to implement new laws softened demand at the same time that companies in the industry expanded in response to these statutory changes. This led to the first sign of weakened U.S. environmental companies and to their uncertainty about how to invest for the future. A subsequent foreign takeover wave changed the ownership of many of the major companies in the U.S. air and water pollution equipment industries. This early sign of a negative effect of environmental policy on the competitiveness of the environmental industry went unheeded, partially masked by persistent overall growth.

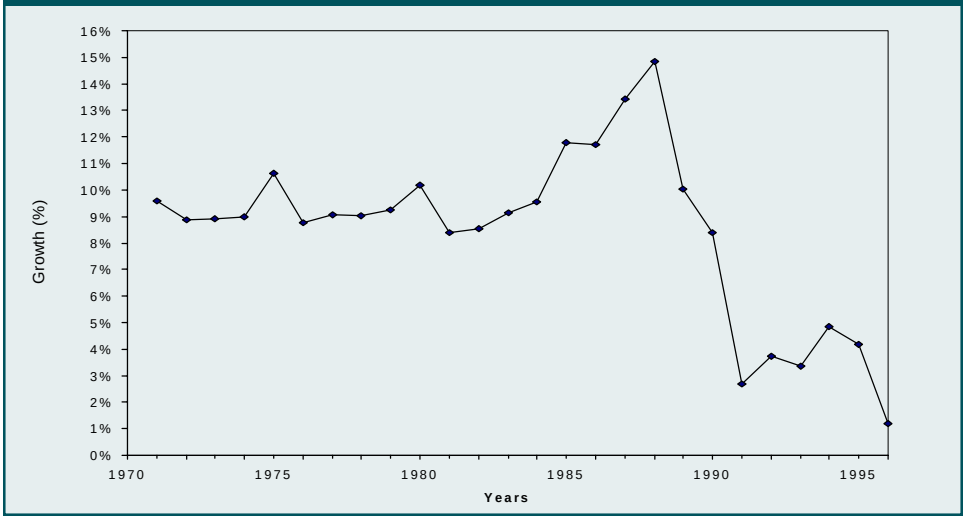
As illustrated in Figure 1, regulation carried double-digit environmental industry growth into the 1990s. The environmental industry, however, did not realize it had become increasingly dependent on "fixing" end-of-pipe problems, on addressing the consequences of years of industrialization without environmental protection, and on undoing governments' own environmental quality legacies.

For the first time in nearly a century, air and water quality ceased to deteriorate and in many locations actually improved.

By the mid-1990s, an American consensus celebrated a significant reversal in the nation's environmental quality. For the first time in nearly a century, air and water quality ceased to deteriorate and in many locations actually improved. In other words, absent disasters, the environment slid slightly down the political priority list as environmental performance progressed from being generally deplorable in the 1960s to moderately acceptable in the 1990s.

At the same time, many people have come to view the interventions of government in society, and especially in business, as too intrusive in a world in which economic competition demands quick reactions, high efficiency, and the adoption of new technology. The momentum of the deregulation movement is manifest in an erosion of environmental regulatory activity and enforcement—and in some cases environmental quality. The combined effect of progress on the most obvious and tangible environmental problems, the desire to downsize government, and an increasingly global economy have resulted in stagnation in the demand for improvement of environmental quality in the United States and a corresponding competitive decline in many sectors of the U.S.

Figure 1. Annual Growth of Environmental Industry, 1970–1996



environmental industry. Simultaneously, however, environmental problems, measured on a global scale, have reached the point that international responses have begun. Clearly, environmental policy and the environmental industry are at a crossroad. New government policies undertaken during the second Clinton administration will have a significant effect on environmental quality and on the future competitiveness of the U.S. environmental industry for years to come.

Clearly, environmental policy and the environmental industry are at a crossroad.

1.2 Defining the Environmental Industry

For the purposes of this report, the environmental industry includes all revenue-generating activities associated with (1) compliance with environmental regulations; (2) environmental assessment, analysis, and protection; (3) pollution control, waste management, and remediation of contaminated property; (4) provision and delivery of the environmental resources of water, recovered materials, and clean energy; and (5) technologies and activities that contribute to increased energy and resource efficiency, higher productivity, and sustainable economic growth (enabling pollution prevention).

Until fairly recently, the industry had not been analyzed statistically in parts or as a whole. U.S. government efforts to develop comprehensive data on the industry have been limited, in part because its business activities fit *within* several categories used in the Standard Industrial Classification (SIC) system, making it difficult to perform discrete exami-

In 1995, EPA estimated that the industry represented 0.8% of the national economy in 1991.

nations of the industry. Some information about such disparate segments as garbage collection and air pollution control equipment manufacturing, for instance, was collected periodically but not systematically by EPA or others. In 1995, EPA estimated that the industry represented 0.8% of the national economy in 1991. Other attempts to quantify the U.S. environmental market focused on solutions to problems rather than on revenue generation by business type; these attempts suffer from double counting and weak comparability from sector to sector. The most comprehensive data have been developed in the private sector.

In 1996, based on private-sector data, the broad and segmented U.S. environmental industry represented total revenues of $181 billion, generated by more than 30,000 private-sector companies and more than 80,000 public-sector entities (mostly related to water); employed more than 1.3 million Americans; and generated $16 billion in export or overseas service revenues in the $452 billion global environmental market. Despite its size and economic importance, the industry in its entirety remains poorly understood. For example, the degree to which small- and medium-sized revenue-generating entities are a vital part of the industry is little understood. Firms with less than $100 million in annual sales generate a majority of industry revenues, and a large majority of firms generate under $10 million in annual revenues, most well under $5 million. Table 1 contains a basic summary of pertinent data organized into industry segments by type of business.[2]

The federal government has attempted to gather more complete information on the U.S. environmental industry; a worldwide effort led by the Organization for Economic Cooperation and Development (OECD) is also under way. EPA made an initial effort to define the goods and services that constitute environmental protection activities in the United States in 1995.[3] More recently, the Department of Commerce (DOC) led a U.S. effort in which the Bureau of the Census conducted a survey on the environmental industry, with participation from EPA; Environmental Business International, Inc. (EBI); and other organizations. Census data

[2] All environmental industry data used in this study are drawn from the Environmental Business International, Inc. (EBI), 1996 survey of the industry, including projections, and are reproduced by permission. EBI, an independent business research firm, has defined, classified, and quantified the environmental industry since 1987, serving as a *de facto* census taker for the U.S. environmental industry. EBI collects survey data from more than 1,400 environmental companies on an annual basis, with response rates typically in the 70%–75% range.

[3] EPA, *The U.S. Environmental Protection Industry: A Proposed Framework for Assessment* (Sept. 1995).

Table 1. The U.S. Environmental Industry, 1996: Revenue and Growth

Environmental Industry Segment	1996 Revenues ($ billions)	1995-96 Growth (%)	Companies/ Entities	1996 Exports ($ millions)	1996 Employment
Services					
Analytical Services	1.2	-2.5	1,200	28	14,000
Wastewater Treatment Works	24.0	2.5	27,000	178	103,100
Solid Waste Management	33.9	4.3	5,900	1,424	245,700
Hazardous Waste Management	6.0	-3.5	1,900	179	51,600
Remediation/Industrial Services	8.6	-0.3	3,800	257	95,300
Consulting & Engineering	15.2	-1.9	4,300	1,338	178,900
Equipment					
Water Equipment & Chemicals	17.5	6.0	3,200	3,346	115,300
Instruments & Information Systems	3.1	4.2	900	1,601	28,500
Air Pollution Control Equipment	15.7	4.3	1,100	1,565	108,700
Waste Management Equipment	12.0	2.1	2,800	1,915	93,500
Process & Prevention Technology	0.8	2.4	300	10	20,000
Resources					
Water Utilities	26.4	4.2	58,000	132	119,800
Resource Recovery	14.3	-14.9	4,200	2,897	136,600
Environmental Energy Sources	2.4	3.5	600	1,142	26,400
Total	**181.1**	**1.2**	**115,200**	**16,012**	**1,337,400**

Source: Environmental Business International, Inc., San Diego, CA. Copyright EBI, Inc.

Today's environmental industry activities can be divided into three major categories depending on the dominant source of revenue generation.

were recently released for 1995 revenues.[4] These data, with technical adjustments, are roughly comparable to the EBI data. The OECD worldwide definition and characterization effort began in 1995. This effort, which seeks to establish international agreement on segment definitions, proved difficult since few broadly accepted SIC-type designations exist for environmental companies.

Today's environmental industry activities can be divided into three major categories depending on the dominant source of revenue generation:

- ***Service segments.*** Operations that obtain revenues by collecting fees for services rendered.
- ***Equipment segments.*** Manufacturers that obtain revenues primarily from the sale or lease of equipment.
- ***Resource segments.*** Entities that obtain revenues from the sale of resources (e.g., water or energy) or reclaimed materials (such as steel or paper).

Table 2 provides a concise yet inclusive description of the environmental industry using these three broad categories organized into 14 business segments. This evolving structure is consistent with traditional industry analyses, such as the SIC: It categorizes the industry by type of business, rather than by type of problem solved.

Two other views of the industry yield valuable perspective. These views organize the industry by (1) environmental media and (2) ownership. The first approach, environmental media, is important because a large majority of environmental companies focus on only one of the environmental media and because the competitive conditions for companies in each of the media vary significantly. The second approach, ownership, has value because environmental businesses differ widely in their goals, frameworks for decision making, and other essential characteristics depending on whether they are in the public or private sector.

[4] *Survey of Environmental Products and Services: 1995.*

Table 2. U.S. Environmental Industry Segments

Segment	Description	Examples of Clients
Environmental Services		
Environmental Testing & Analytical Services	Provide testing of "environmental samples" (soil, water, air, and some biological tissues).	Regulated industries, government, environmental consultants, hazardous waste and remediation contractors.
Wastewater Treatment Works	Collect and treat residential, commercial, and industrial wastewaters. These facilities are commonly known as POTWs, or publicly owned treatment works.	Municipalities, commercial establishments, and all industries.
Solid Waste Management	Collect, process, and dispose of solid waste.	Municipalities and all industries.
Hazardous Waste Management	Manage ongoing hazardous waste streams, medical waste, nuclear waste.	Chemical and petroleum companies, government agencies.
Remediation/Industrial Services	Provide physical cleanup of contaminated sites and buildings; provide environmental cleaning of operating facilities.	Government agencies, property owners, industry.
Environmental Consulting & Engineering	Provide engineering, consulting, design, assessment, permitting, project management, operations and maintenance, monitoring.	Industry, government (including municipalities), waste management companies, POTWs.
Environmental Equipment		
Water Equipment & Chemicals	Produce equipment, supplies, and maintenance in the delivery and treatment of water and wastewater.	Municipalities and all industries.

Table 2. *Continued*

Segment	Description	Examples of Clients
Environmental Equipment		
Instruments & Information Systems	Produce instrumentation for the analysis of environmental samples, and provide information systems and software.	Analytical service companies, government, and regulated companies.
Air Pollution Control Equipment	Produce equipment and technologies to control air pollution, including vehicle controls.	Utilities, waste-to-energy industries, auto industry, other industries.
Waste Management Equipment	Produce equipment for handling, storing, or transporting solid, liquid, and hazardous waste, including disposal, recycling, and remediation equipment.	Municipalities, waste-generating industries, solid waste companies.
Process & Prevention Technology	Provide equipment and technology for in-process (rather than end-of-pipe) pollution prevention and waste treatment and recovery.	All industries.
Environmental Resources		
Water Utilities	Sell water to end users.	Consumers, municipalities, all industries.
Resource Recovery	Sell materials recovered and converted from industrial by-products and postconsumer waste.	Municipalities, waste-generating industries, solid waste companies.
Environmental Energy Sources	Sell power and systems in solar, wind, geothermal, small-scale hydro, energy efficiency, and DSM.	Utilities, all industries, and consumers.

Source: Environmental Business International, Inc., San Diego, CA. Copyright EBI, Inc.

1.2.1 Breakdown of Industry Segments by Media: Air, Water, Solid Waste, Hazardous Waste, Remediation, and Multimedia

Most environmental industry businesses are active in only one of the media (air, water, or hazardous waste, for instance), but some companies participate across all media segments. Table 3 presents this analysis and also provides a breakdown of the U.S. environmental industry by the media categories of air, water, solid waste, hazardous waste, remediation, and multimedia.

Most environmental industry businesses are active in only one of the media (air, water, or hazardous waste, for instance), but some companies participate across all media segments.

By far the two dominant media categories in terms of revenues are water and solid waste; these together account for more than 70% of the industry's revenue generation. This dominance underscores the importance to environmental companies of integrating themselves securely into these ongoing functions. Air, ongoing hazardous waste generation, and remediation each account for similar revenue generation by environmental companies, with multimedia coming in a distant last.

On the other axis of the table, it is worth noting that consulting and engineering firms, analytical testing companies, and instrumentation firms are the most diverse in terms of media orientation. Companies in these segments are less susceptible to media-focused phases of growth or decline, but perhaps more important, they are key figures in all types of environmental solutions. The best situated are able to provide extra value to their customers through multimedia, industry-oriented environmental solutions that yield competitive advantages.

Table 3. The U.S. Environmental Industry, 1996: Revenues by Media (in $ billions)

Segment	Air	Water/ Wwater	Hazardous Waste	Reme-diation	Solid Waste	Multimedia	Total
Services							
Analytical Services	0.1	0.3	0.2	0.4	0.1	0.0	1.2
Wastewater Treatment Services		24.0					24.0
Solid Waste Management					33.9		33.9
Hazardous Waste Management			6.0				6.0
Remediation/Industrial Services				8.6			8.6
Consulting & Engineering	1.4	4.2	3.7	3.5	1.1	1.4	15.2
Equipment							
Water Equipment and Chemicals		17.5					17.5
Instrument Manufacturing	0.8	1.1	0.5	0.7	0.0	0.1	3.1
Air Pollution Control Equipment	15.7						15.7
Waste Management Equipment			2.6	1.0	8.4		12.0
Process & Prevention Technology						0.8	0.8
Resources							
Water Utilities							26.4
Resource Recovery		26.4			13.9		14.3
Environmental Energy Sources			0.4			2.4	2.4
Total all segments	**17.9**	**73.5**	**13.4**	**14.2**	**57.4**	**4.7**	**181.1**
Total (%)	**9.9%**	**40.6%**	**7.4%**	**7.8%**	**31.7%**	**2.6%**	

Source: Environmental Business International, Inc., San Diego, CA

1.2.2 Private- Versus Public-Sector Participation in the Industry

Early classifications of the environmental industry included only the private sector or only revenues generated by commercial operations collecting service fees or selling equipment. Now, however, the revenue-generating activities of public-sector entities for water, waste, and other environmental infrastructure activities are commonly defined and quantified as part of the industry. Public-sector revenues arise mostly from direct charges by municipal entities to industry, commercial facilities, and residences for water delivery; wastewater treatment; and waste collection, recycling, and disposal services. Some of these revenues are still derived indirectly from fees assessed through general taxation. Revenues in these segments tend to track with several underlying factors, including population growth, economic growth, inflation rates, changes in regulatory requirements, and changes in technology.

As noted, the environmental industry that existed before the wave of environmental legislation in the early 1970s was composed predominantly of public-sector-funded activities with some private-sector support. Since then, the private sector has played an increasing role, making the industry more diverse and increasing the percentage of the industry's revenues generated by the private sector. Table 4 displays each segment's revenue generation in the United States in 1996 and apportions it among public-sector and private-sector entities.

The private sector has played an increasing role, making the industry more diverse and increasing the percentage of the industry's revenues generated by the private sector.

The largest segments in terms of revenues (the environmental infrastructure segments of solid waste management, water treatment works, and water utilities) have evolved, or are starting to evolve, from purely municipal operations. The privatization of the solid waste management segment in the United States and the fact that U.S. solid waste firms are by far the most competitive internationally is no coincidence. The relative lack of privatization in the water segments has made this U.S. business sector either nonexistent or woefully noncompetitive in foreign markets. The weakness of these segments of the U.S. industry may be compared to the strength of French and British water treatment and water utility entities that were gradually transferred to private management over the past 30 years in France and privatized completely in England in 1989.

Firms in the private sector predominate in most of the other environmental industry segments with the exception of the analytical services sector. That sector includes a number of publicly owned laboratories that mostly perform water quality testing. In addition, some public facilities handle hazardous waste, provide recycling operations, and operate renewable energy systems.

Table 4. The U.S. Environmental Industry, 1996: Public Sector vs. Private Company Revenue Generation (in $ billions)

Environmental Industry Segment	Total 1996	Revenue Generator Pub%	Priv%	Pub$	Priv$
Analytical Services	1.2	9	91	0.1	1.1
Water Treatment Works	24.0	96	4	23.1	1.0
Solid Waste Management	33.9	36	64	12.2	21.7
Hazardous Waste Management	6.0	10	90	0.6	5.4
Remediation/Industrial Services	8.6	0	100	0.0	8.6
Consulting & Engineering	15.2	0	100	0.0	15.2
Water Equipment and Chemicals	17.5	0	100	0.0	17.5
Instruments & Information Systems	3.1	0	100	0.0	3.1
Air Pollution Control Equipment	15.7	0	100	0.0	15.7
Waste Management Equipment	12.0	0	100	0.0	12.0
Process & Prevention Technology	0.8	0	100	0.0	0.8
Water Utilities	26.4	83	17	21.9	4.5
Resource Recovery	14.3	22	78	3.2	11.2
Environmental Energy Sources	2.4	5	95	0.1	2.3
Total	**181.1**	**34**	**66**	**61.1**	**120.0**

Note: Revenue generator is private company or public sector entity collecting revenues; source is the customer.
Source: Environmental Business International, Inc., San Diego, CA

1.3 Industry Performance: $181 Billion in Revenues, but Flat Growth and Declining Returns

From modest beginnings with 1970 revenues of less than $20 billion, the U.S. environmental industry grew into a $181 billion giant by 1996, generating $16 billion of those revenues abroad.

From modest beginnings with 1970 revenues of less than $20 billion, the U.S. environmental industry grew into a $181 billion giant by 1996, generating $16 billion of those revenues abroad. The industry is increasingly recognized as a vital part of the economy, responsible for more than 1% of total employment in the United States. However, growth in the industry has slowed substantially. While annual revenue increases ranged between 10% and 15% from 1985 to 1990, they ranged between 2% and 6% from 1990 to 1995. Growth bottomed out at just 1.2% in 1996, as seen in Figure 1, less than the growth rate for the overall economy.

The environmental industry now displays many characteristics of maturing industries, such as decelerating growth, heightened competition,

growing sophistication among its client base, greater emphasis on marketing, consolidation of market share in larger players, and heightened merger and acquisition activity, among other characteristics. Beyond facing the challenges of a maturing industry, however, environmental companies have suffered through a difficult period of increasing regulatory uncertainty since 1991, as policymakers emphasized the primary importance of economic growth. For example, the Council on Competitiveness established by President Bush criticized, among other things, the Clean Air Act amendments passed in 1990, and announced, for the sake of improving the economy, a moratorium on new regulations. Table 5 displays revenue growth data from 1989 to 1996, a period that overlaps with the period of regulatory uncertainty.

The most important cause of the collapse of environmental industry growth in 1991 was the recession. A bad economy exposed how truly discretionary some environmental spending was becoming, now that substantial compliance with environmental regulations had been achieved. What was once promoted by the financial community and Wall Street as a recession-proof industry was revealed as recession prone.

Although the recession quickly yielded to a strong economic expansion in the 1990s, attempts to weaken environmental laws and regulations and regulatory uncertainty persist, and the regulatory and enforcement foundation of the environmental industry has weakened further over time. Inactivity on environmental legislation has complicated executive branch plans for program reform, however, and promoted administrative uncertainties that have led regulated communities to postpone and cancel environmental projects. Many environmental executives indicate that a growing portion of environmental companies are shifting the basis of their business to resource productivity, industrial competitiveness, and other economic factors, although public demand and government regulatory policies will continue to establish the economic floor for the industry for the foreseeable future.

Industry statistics show that, to complement traditional lines of business, environmental companies leading this transition have already established new practice areas, new technical offerings, and new products and services. Pollution control, waste management, and cleanup driven by regulation still represent the large majority of revenues in the environmental industry. However, customer demand is beginning to shift to pollution prevention, advanced manufacturing, and resource-related investments not wholly dependent on regulations. These sectors have shown the highest rates of revenue growth in recent years. For example,

Customer demand is beginning to shift to pollution prevention, advanced manufacturing, and resource-related investments not wholly dependent on regulations.

Table 5. The U.S. Environmental Industry, 1989-1996

Revenue ($ billions) and Growth (percentage)

Environmental Industry Segment	1989 Revenues	1988–89 Growth	1990 Revenues	1989–90 Growth	1991 Revenues	1990–91 Growth	1992 Revenues	1991–92 Growth
Services								
Analytical Services	1.5	21	1.5	6	1.6	1.3	1.4	-9.0
Wastewater Treatment Works	19.2	5	20.4	6	21.1	3.2	21.5	2.1
Solid Waste Management	24.2	13	26.1	8	27.0	3.4	28.2	4.4
Hazardous Waste Management	5.7	21	6.3	11	6.4	2.2	6.6	3.0
Remediation/Industrial Services	7.3	10	8.0	9	7.3	-8.4	7.8	6.4
Consulting & Engineering	10.5	25	12.5	19	13.5	8.0	14.3	5.9
Equipment								
Water Equipment and Chemical	12.8	7	13.5	5	14.1	3.9	14.7	4.3
Instruments & Information System	1.6	19	2.0	21	2.3	15.4	2.6	11.8
Air Pollution Control Equipment	12.1	7	13.1	9	13.5	2.8	13.8	2.1
Waste Management Equipment	9.8	11	10.4	6	10.8	3.8	11.1	2.8
Process & Prevention Technology	0.3	36	0.4	37	0.5	22.0	0.6	20.0
Resources								
Water Utilities	18.8	6	19.8	5	21.0	6.1	21.9	4.3
Resource Recovery	12.0	4	13.1	9	12.0	-8.4	12.2	1.6
Environmental Energy Sources	1.6	12	1.8	11	1.9	7.4	2.0	4.8
Total	**137.4**	**17**	**148.9**	**8**	**152.9**	**2.7**	**158.5**	**3.7**

water treatment equipment for discharge is losing market share to water treatment and purification equipment for reuse. Expenditures on waste management equipment manufactured for containment, collection, and transportation of solid waste for efficient *disposal* are increasingly being replaced by investments in equipment for sorting, processing, and baling materials for *recovery*. Waste management services are focusing on collection and recovery, and companies are generating profits from both services rendered *and* from sale of recovered material. Demand for compliance-oriented consulting has peaked, while demand for strategic environmental management, pollution prevention, and specialized process engineering often goes unmet.

Revenue generation in the segments of the industry most motivated by compliance with regulations (air pollution control, hazardous waste management, and site remediation, for instance) has already passed its peak. Transitions are in full swing across all environmental industry segments. Many industry executives told DOC that the industry cannot

Table 5. *Continued*

Revenue ($ billions) and Growth (percentage)

Environmental Industry Segment	1993 Revenues	1992–93 Growth	1994 Revenues	1993–94 Growth	1995 Revenues	1994–95 Growth	1996 Revenues	1995–96 Growth
Services								
Analytical Services	1.4	0.7	1.3	-7.0	1.2	-8.3	1.	-2.5
Wastewater Treatment Works	22.0	2.3	22.7	3.2	23.4	3.3	24.0	2.5
Solid Waste Management	29.4	4.3	31.0	5.4	32.5	4.8	33.91	4.3
Hazardous Waste Management	6.5	-2.1	6.4	-1.4	6.2	-3.1	6.0	-3.5
Remediation/Industrial Services	8.1	5.0	8.4	3.5	8.6	2.3	8.6	-0.3
Consulting & Engineering	14.6	1.8	15.3	5.1	15.5	1.3	15.2	-1.9
Equipment								
Water Equipment and Chemical	15.0	2.2	15.6	4.3	16.5	5.8	17.5	6.0
Instruments & Information System	2.7	6.0	2.9	4.6	3.0	5.7	3.1	4.2
Air Pollution Control Equipment	14.1	2.9	14.5	2.5	15.0	3.5	15.7	4.3
Waste Management Equipment	10.9	-1.8	11.2	2.8	11.7	4.6	12.0	2.1
Process & Prevention Technology	0.7	14.0	0.8	11.1	0.8	7.9	0.8	2.4
Resources								
Water Utilities	23.1	5.5	24.2	4.7	25.3	4.5	26.4	4.2
Resource Recovery	13.3	8.9	15.4	15.8	16.9	9.7	14.3	-14.9
Environmental Energy Sources	2.1	4.5	2.2	6.9	2.3	4.5	2.4	3.5
Total	**163.9**	**3.4**	**171.9**	**4.9**	**179.0**	**4.2**	**181.1**	**1.2**

Note: The corresponding table in the Executive Summary has been shortened.
Source: Environmental Business International, Inc., San Diego, CA

last in its current form. Overall growth in the industry declined to about 1% in 1996, as noted earlier, and growth in the remediation, solid waste management, and pollution-control-related segments of the domestic market has nearly reached a standstill (although new clean air regulations may restore growth in air-related segments). Beyond showing the signs of a maturing industry, these segments face the following fundamental long-term challenge: The environmentally negligent and resource-rich economy that created much of the industry's revenue opportunity no longer exists. We are no longer creating Superfund sites at the rate we did; we no longer use asbestos, and most new manufacturing and industrial facilities are now designed with increased material efficiency and pollution prevention in mind. The following are among the characteristics of the industry and its market segments today:

With supply exceeding demand, the power in environment-related business transactions has swung to the buyer in many sectors.

- ***Increased sophistication of buyers.*** Customers find environmental compliance less mysterious. They are in some cases internally managing functions that were once contracted out, and they have grown more exacting and demanding in pricing and contract mechanisms. In other cases, they have outsourced entire departments or adopted new products or processes that avoid regulatory issues.

- ***Overcapacity.*** High growth and relatively low barriers to entry attracted numerous competitors right up to the time of the dramatic drop-off in growth rates in the early 1990s. The result has been overcapacity in many segments, most noticeably in hazardous waste management, analytical services, consulting and engineering, and air pollution control equipment.

- ***Transition from a sellers' to a buyers' market.*** With supply exceeding demand, the power in environment-related business transactions has swung to the buyer in many sectors. Throughout the 1980s, environmental companies were in great demand. Many turned away work because of lack of capacity. In today's buyers' market, competition has increased dramatically, and customers play off their providers against each other to obtain a reduced price.

- ***Declining prices.*** Pricing declined in real terms in many environmental service segments from 1992 to 1996. Dramatic drop-offs occurred in environmental testing, for instance, and in many cases prices are less than half of what they were. Rate adjustments for consulting and engineering firms—which historically increased every year or so—have remained flat and in some cases have declined.

- ***Elevated importance of marketing and customer service.*** Another characteristic of a maturing industry is an emphasis on sales and marketing in response to heightened competition and reduced profits. Many environmental companies have increased their business development spending, although at roughly 8% of revenues, marketing costs remain lower than in most industries, even in industries with strong service components.

- ***Declining financial performance.*** Declining demand, declining prices, and increased competition have all added up to declining financial performance in the environmental industry. By the mid-

1990s, average profit margins were roughly 50% to 70% less in each segment than they were in 1990.

- ***Expanded focus on cost control.*** Tougher economic times have led most companies to focus on short-term objectives, eking out earnings rather than investing for the future. Cost control has led to layoffs, consolidations, and other corporate "efficiency" moves. Although such moves lead to short-term gains, they can weaken the competitiveness of companies in the long run.

- ***Consolidation.*** Many of the relatively few large environmental companies have accelerated their growth in the past few years through acquisition. Most segments are consolidating at the top as large and mid-sized firms are merging. Although economies of scale are not as apparent in the environmental industry as in other industries, pursuit of growth (especially for investor-owned, publicly traded firms) is driving acquisitions. Larger companies are usually better suited to undertaking serious and sustainable overseas ventures, so consolidation in the industry serves to support overall international competitiveness.

- ***Polarization.*** The large firms are getting larger, in part because of the belief that to achieve economies of scale they need to be full-service providers and have financial strength. Small environmental companies with revenues in the under-$10 million range continue to predominate, however. The typical environmental firm has less than $1 million in revenues. New entrants continue to populate the service segments because of the relatively low capital cost of entry. A final factor leading to polarization of the industry into the large and the small is that individuals or groups often spin off of larger firms (or out of consolidating firms) to start their own businesses.

- ***Reduced business valuations.*** Regulatory-driven business neither has disappeared nor will completely disappear, but companies primarily dependent on revenues from traditional services and equipment sales have passed their valuation peak. The collective market value of publicly traded firms in hazardous waste management and environmental consulting and engineering, for instance, fell 14% in 1995, and valuations for companies in these services segments have fallen 20% to 25% from 1993 to 1996.

The large firms are getting larger, in part because of the belief that to achieve economies of scale they need to be full-service providers and have financial strength.

In general, the financial performance of the environmental industry has been declining by a number of measures since 1991. Profitability levels are down in virtually every segment. Operating margins for environmental consulting firms, which averaged in the range of 8% to 12% in the period 1988 to 1990, averaged 5% to 7% in 1994 and 1995. Environmental testing laboratories have been lucky to reach even 5% operating margins during the past 3 years. Solid waste companies, which once returned up to and over 20% to the delight of investors and executives, saw returns fall into the 10% to 15% range.

Perhaps the best indication of the relatively poor performance of the environmental industry has been the performance of its securities on Wall Street. Table 6 compares the performance of the *Environmental Business Journal* (EBJ) Index of 240 environmental companies with that of the Dow Jones Industrials, the S&P 500, and the NASDAQ Composite Index from 1991 to 1996. While annualized appreciation in the NASDAQ over the 6-year period was 22% and the Dow was 16%, the EBJ gained only 6%, indicative of both the poor financial performance and the market uncertainties that the environmental industry continues to face.

1.4 The Global Environmental Market

In 1996, the global environmental market represented $452 billion in revenues, including nearly $172 billion in the United States.

In 1996, the global environmental market represented $452 billion in revenues, including nearly $172 billion in the United States. Table 7 presents a matrix of environmental industry business segments and major regions of the world. Almost 87% of global environmental revenue generation is in the United States, Japan, and Western Europe, and that the "resource infrastructure" segments of water/wastewater and solid waste/resource recovery represent over 60% of the market.

While the established economies of the world represent by far the largest environmental markets, growth rates will be much higher in newly industrialized countries. Table 8 presents growth projections for the global environmental market on a regional basis. Economic growth is a major component in determining environmental market growth. A nation can have all the public support for environmental protection and all the government policy, legislation, regulation, and enforcement mechanisms in place, but without relative economic prosperity, environmental markets fail to materialize. The experience of U.S. environmental firms in the home market from 1991 to 1993 demonstrated the unsettling fact that even in well-developed environmental markets, environmental

Table 6. EBJ Index Stock Performance, 1991-1996 (in percentage gains)

Selected Indices	1996	1995	1994	1993	1992	1991	6 Yrs	Annual
EBJ Index	12.8	21.2	-7.9	-2.1	-0.5	18.6	145.5	6.5
DOW	26.0	33.5	2.1	11.6	4.2	20.5	240.7	15.8
NYSE	19.1	31.3	-3.1	6.1	4.7	27.7	215.0	13.6
S&P	20.3	34.1	-1.5	6.0	4.5	26.9	223.4	14.3
NASDAQ	22.7	39.2	-3.2	11.4	15.5	58.0	336.1	22.4
EBJ Index Detail								
Instrumentation	**10.5**	**41.2**	**3.0**	**8.7**	**11.2**	**43.5**	**278.8**	**18.6**
EBJ Conglomerates	15.9	32.5	0.4	5.8	5.8	18.8	205.0	12.7
Water Equipment & Chemicals	23.2	16.5	-5.7	-11.7	11.5	39.3	185.6	10.9
Water Utilities	21.2	13.4	-13.4	9.2	8.3	12.0	157.7	7.9
Solid Waste Management	37.4	49.1	-2.4	-12.4	-26.7	10.7	142.1	6.0
Resource Recovery	-5.5	20.1	-14.9	1.9	3.2	22.3	124.2	3.7
Waste Management Equipment	11.8	8.9	-2.8	-1.6	-1.5	7.0	122.7	3.5
Energy Sources	5.6	-6.1	-19.2	11.5	15.2	3.6	106.6	1.1
Air Pollution Control Equipment	17.3	-6.3	-20.6	-12.6	2.2	16.3	90.7	-1.6
Remediation/Ind'l Services	1.7	3.0	-1.0	-13.6			89.6	-2.7
Consulting & Engineering	-5.5	9.3	-19.8	-5.4	-9.8	11.3	78.7	-3.9
Hazardous Waste Management	-4.0	-14.0	-18.0	-23.4	-22.0	14.6	46.4	-12.0
Process & Prevention Technology	-22.2	43.2	-43.8				62.6	-14.5

Note: Blank spaces indicate that the segment was not calculated for that year.
Source: Environmental Business International, Inc., San Diego, CA

expenditures motivated by regulations and enforcement are sensitive to customers' "ability to pay."

Asia, particularly the Southeast Asian nations but also most of the region outside Japan, has the highest environmental market growth rate, projected to average 14% to 16% annually over the next few years. This rate may decline somewhat because of recent financial upheavals, particularly in Korea, Thailand, and Indonesia, but should remain 2% to 3% above their economic growth. The Latin American market should also post double-digit growth. The market in parts of Central Europe may be in that range, although the market of much of the former Soviet Union is

Table 7. The Global Environmental Market, 1996

	USA	W Europe	Japan	Asia	Latin Am	Canada
Equipment						
Water Equipment & Chemicals	16.0	10.5	5.6	2.7	0.9	1.2
Air Pollution Control	15.4	7.3	3.3	0.9	0.4	0.6
Instruments & Information Systems	1.8	1.6	1.0	0.2	0.2	0.1
Waste Management Equipment	10.7	9.1	8.6	1.3	0.7	0.8
Process & Prevention Technology	0.9	0.5	0.5	0.1	0.1	0.1
Services						
Solid Waste Management	32.7	29.5	29.6	3.4	1.3	2.2
Hazardous Waste Management	5.9	5.2	3.8	0.5	0.2	0.4
Consulting & Engineering	14.2	8.4	1.1	0.8	0.3	0.9
Remediation/Industrial Services	8.3	3.7	1.1	0.4	0.2	0.5
Analytical Services	1.2	1.0	0.5	0.1	0.1	0.1
Water Treatment Works	24.6	21.8	9.6	2.7	1.8	2.0
Resources						
Water Utilities	27.0	19.7	12.2	4.5	2.1	2.0
Resource Recovery	11.6	13.6	9.2	1.1	0.4	0.7
Environmental Energy	1.4	1.5	1.0	0.4	0.2	0.1
Total ($ billions)	**171.8**	**133.4**	**87.1**	**18.9**	**8.8**	**11.7**
Total (%)	**38.0%**	**29.5%**	**19.3%**	**4.2%**	**1.9%**	**2.6%**

In aggregate terms, global environmental revenues in the year 2001 are projected to be $100 billion higher than they were in 1994—more than a 23% gain in 7 years.

not expected to grow more than 4% to 6% per year. The African market can expect impressive growth, particularly for water-related projects, but from a small base. The African market is so small that a single significant World Bank or African Development Bank project can have a significant effect on the numbers.

In aggregate terms, global environmental revenues in the year 2001 are projected to be $100 billion higher than they were in 1994—more than a 23% gain in 7 years, a dollar figure comparable to Sweden's and Indonesia's annual gross domestic product. The three largest regions (the United States, Japan, Western Europe) will account for 62% of this gain, a

Table 7. *Continued*

	Aus/NZ	E Europe	MidEast	Africa	Total ($billions)	Total (percent)
Equipment						
Water Equipment & Chemicals	0.7	0.8	0.4	0.3	38.9	8.6
Air Pollution Control	10.3	0.4	0.3	0.0	29.0	6.4
Instruments & Information Systems	0.1	0.1	0.1	0.0	5.2	1.1
Waste Management Equipment	0.4	0.4	0.2	0.1	32.4	7.2
Process & Prevention Technology	0.0	0.0	0.0	0.0	2.3	0.5
Services						
Solid Waste Management	1.4	1.1	0.8	0.3	102.2	22.6
Hazardous Waste Management	0.2	0.3	0.2	0.0	16.8	3.7
Consulting & Engineering	0.5	0.3	0.2	0.1	26.8	5.9
Remediation/Industrial Services	0.3	0.2	0.3	0.0	15.0	3.3
Analytical Services	0.1	0.1	0.0	0.0	3.2	0.7
Water Treatment Works	1.2	0.6	0.3	0.2	64.8	14.3
Resources						
Water Utilities	1.3	2.4	1.2	0.8	73.0	16.2
Resource Recovery	0.3	0.4	0.1	0.1	37.7	8.3
Environmental Energy	0.1	0.1	0.0	0.1	4.9	1.1
Total ($ billions)	**16.8**	**7.1**	**4.3**	**2.2**	**452.1**	
Total (%)	**1.5%**	**1.6%**	**0.9%**	**0.5%**		**100%**

Note: Export data shown in Tables 7 and 10 have been expanded in comparison with corresponding tables in the Executive Summary.
Source: Environmental Business International, Inc., San Diego, CA

substantial share, but smaller than their 87% share of today's market. A gain of $16 billion in environmental revenues is expected in Asia outside Japan between 1994 and 2000, even with downward adjustments following the recent regional financial crisis. This region still represents the best opportunity for international environmental business. Latin America is not far behind, however, thanks to growth in demand, improved political and financial situations, and its geographic proximity and cultural relationships with North America.

Regional market characterization can be misleading if the groupings are too large. Western Europe, for instance, in spite of the efforts of the

Table 8. Global Environmental Market Growth

Country	1996 ($ billions)	1995–96 (percent)	1996–2000 (percent)
USA	171.8	0.8	1.8
Western Europe	133.6	3	2.8
Japan	87.1	2	2.6
Rest of Asia	18.9	16	10
Latin America	8.8	12	12
Canada	11.6	3	3
Australia/NZ	6.8	5	4
Eastern Europe/CIS	7.1	6	8
Middle East	4.3	6	8
Africa	2.2	10	10
Total	**452.2**	**2.7**	**5**

Source: Environmental Business International, Inc., San Diego, CA

European Union, is not one market but a geographic collection of 16 markets. A more useful approach is to classify Western European nations in tiers based on maturity of environmental markets and type of market motivators.[5] Germany and most of Scandinavia are in the first, most mature tier; France and the United Kingdom are in tier 2; Italy and Spain are in tier 3; and Greece and Portugal are in tier 4. The Asian market can be viewed through the lens of a similar system of tiers. Japan is in a class by itself; Singapore and Hong Kong are in tier 2; South Korea and Taiwan are in tier 3; Thailand, Indonesia, Malaysia, and the Philippines are in tier 4; and China, India, and others lag behind.

1.5 Industry Trade Performance: Export Revenue and Percentage of Revenues From Exports

Little doubt exists that the U.S. market for environmental products and services is the world's largest. The U.S. environmental industry also has the greatest overall capacity to solve and prevent environmental problems. In doubt, however, is which nation will be the environmental industry export leader in terms of total revenues generated outside its borders, including revenues from service and equipment sales and repatriated profits from ownership of or joint ventures with foreign

[5] Environmental Business International, Inc., 1997.

Table 9. U.S. Environmental Export Performance

	1993	1994	1995	1996
Global Market ($ billions)	412	428	440	452
U.S. Market ($ billions)	160	166	170	172
Non-U.S. Market ($ billions)	252	262	270	280
Exports (%)	5.9%	6.7%	8.2%	8.8%
U.S. Exports ($ billions)	9.6	11.5	14.7	16.0
Trade Surplus ($ billions)	4.8	6.2	8.5	9.3
U.S. Share of Non-U.S. Market (%)	3.8%	4.4%	5.5%	5.7%

Source: Environmental Business International, Inc., San Diego, CA.

companies. Also in doubt is which of the 30,000 U.S. companies can compete effectively in world markets that are geographically remote and in which the competitors are in many cases larger, well financed, and better managed. The stakes are high not only because the global market is $452 billion, but because much of the highest growth is in geographic areas and market segments in which the U.S. environmental industry is least competitive (see Table 11).

Table 9 demonstrates the international trade position of U.S. environmental companies in the years 1993, 1994, 1995, and 1996. Bottom-line figures show $16 billion in U.S. environmental exports in 1996 and a $9.3 billion trade surplus. Still, only 9% of the industry's revenues are generated outside the United States, a figure behind our major competitors. There has been significant improvement in environmental exports in the past few years, however. Exports have risen from $9.6 billion in 1993 to $11.5 billion in 1994 to $14.5 billion in 1995 to $16 billion in 1996. In percentage terms, the proportion of revenues generated outside the United States for U.S. environmental companies has increased from 5.9% to 6.7% to 8.2% in 1995 to 8.8% in 1996, as shown in Table 10.

There has been significant improvement in environmental exports in the past few years.

While the U.S. industry's revenues of $16 billion from environmental exports compares favorably in gross terms with that of major competitors, the fact that only 9% of the industry's revenues are generated from exports places it far behind in relative terms. The 9% figure means that the U.S. environmental industry ranks ahead of only two of the top 13 environmental industries in the world (the industries of Italy and Spain range from 6% to 8%) in this proportional comparison.

Table 10. U.S. Environmental Export Performance, 1993–1996: Trade Balance

1993 U.S. Environmental Trade Balance ($ billions)

Equipment	U.S. Ind	U.S. Mkt	Surplus	Exports	Imports	%Exp
Water Equipment & Chemicals	15	14.4	0.6	2.0	1.4	13
Air Pollution Control	14.1	14.1	0.0	0.8	0.8	6
Instruments & Information Systems	2.7	1.8	0.9	1.1	0.2	42
Waste Management Equipment	10.9	10.5	0.4	0.7	0.3	6
Process & Prevention Technology	0.7	0.7	0.0	0.0	0.0	1
Services						
Solid Waste Management	29.4	29.1	0.3	0.6	0.3	2
Hazardous Waste Management	6.5	6.3	0.2	0.2	0.0	3
Consulting & Engineering	14.6	14.1	0.5	0.7	0.2	5
Remediation/Industrial Services	8.4	8.3	0.1	0.2	0.0	2
Analytical Services	1.6	1.6	0.0	0.0	0.0	2
Wastewater Treatment Works	22	22.5	-0.5	0.1	0.6	0
Resources						
Water Utilities	23.1	23.4	-0.3	0.1	0.4	0
Resource Recovery	13.3	11.4	1.9	2.3	0.4	17
Environmental Energy	2.1	1.5	0.6	0.8	0.2	38
Total	**164.4**	**159.6**	**4.8**	**9.6**	**4.8**	**5.9**

Uneven accuracy and inconsistency in export and trade balance data limit their comparability for all the leading nations. Inconsistency in national environmental industry definitions and data collection methodologies (which should be improved considerably in time with recent OECD leadership) means comparative detailed analysis is extremely difficult. Nevertheless, reconciling information collected from governments, industry associations, and companies around the world into the classification system presented here leads to the following estimates:[6]

Germany and Japan export 18% to 22% of their environmental industry capacity. Canada, the Netherlands, Sweden, Switzerland, and Austria export 12% to 20% of environmental industry capacity. Australia, France, and the United Kingdom export 8% to 12% of their environmental industry capacity. Other nations ahead of the United States in a relative sense include Belgium, Denmark, Norway, and Israel.

[6] Environmental Business International, Inc., 1997.

Table 10. *Continued*

1994 U.S. Environmental Trade Balance

Equipment	U.S. Ind	U.S. Mkt	Surplus	Exports	Imports	%Exp
Water Equipment & Chemicals	15.6	14.7	0.9	2.2	1.3	14
Air Pollution Control	14.5	14.4	0.1	0.8	0.9	5
Instruments & Information Systems	2.9	1.8	1.1	1.3	0.2	45
Waste Management Equipment	11.2	10.5	0.7	0.9	0.2	8
Process & Prevention Technology	0.8	0.8	0.0	0.0	0.0	1
Services						
Solid Waste Management	31	30.6	0.4	0.8	0.4	3
Hazardous Waste Management	6.4	6.3	0.1	0.2	0.1	3
Consulting & Engineering	15.3	14.6	0.7	0.9	0.2	6
Remediation/Industrial Services	8.6	8.4	0.2	0.2	0.0	2
Analytical Services	1.3	1.3	0.0	0.0	0.0	2
Wastewater Treatment Works	22.7	23.3	-0.6	0.2	0.8	1
Resources						
Water Utilities	24.2	24.7	-0.5	0.1	0.6	0
Resource Recovery	15.4	13.0	2.4	3.0	0.6	19
Environmental Energy	2.2	1.5	0.7	0.9	0.2	41
Total	**172.1**	**165.9**	**6.2**	**11.5**	**5.5**	**6.7**

1.6 International Competitiveness of the Industry

Why is the United States behind in terms of percentage of environmental industry revenues generated from exports? Is this trailing position indicative of a competitive disadvantage? If a competitive disadvantage exists, is it industrywide or is it confined to certain sectors? Several observations appear to be important:

- The largest environmental market—at $181 billion—is in the United States. The U.S. market is $85 billion greater than the second largest, Japan's, at $87 billion in 1996. With rapid growth in the U.S. domestic market until 1991, many U.S. firms became complacent at home and felt little incentive to pursue international business.

Table 10. *Continued*

1995 U.S. Environmental Trade Balance

Equipment	U.S. Ind	U.S. Mkt	Surplus	Exports	Imports	%Exp
Water Equipment & Chemicals	16.5	15.4	1.1	2.6	1.5	16
Air Pollution Control	15.0	14.8	0.2	1.2	1.0	8
Instruments & Information Systems	3.0	1.8	1.2	1.4	0.2	47
Waste Management Equipment	11.7	10.9	0.8	1.2	0.4	10
Process & Prevention Technology	0.8	0.8	0.0	0.0	0.0	1
Services						
Solid Waste Management	32.5	31.6	0.9	1.3	0.4	4
Hazardous Waste Management	6.2	6.2	0.0	0.1	0.1	2
Consulting & Engineering	15.5	14.6	0.9	1.1	0.2	7
Remediation/Industrial Services	8.5	8.3	0.2	0.2	0.0	3
Analytical Services	1.2	1.2	0.0	0.0	0.0	2
Wastewater Treatment Works	23.4	24.1	-0.6	0.2	0.8	1
Resources						
Water Utilities	25.3	26.0	-0.7	0.1	0.8	1
Resource Recovery	16.9	13.3	3.6	4.2	0.6	25
Environmental Energy	2.3	1.5	0.8	1.0	0.2	42
Total	**178.9**	**170.4**	**8.5**	**14.7**	**6.2**	**8.2**

The U.S. environmental industry is heavily populated with small and medium-sized companies that have little capability or inclination to export, especially when contrasted with those in Western Europe and Japan.

- Uncertainties regarding international business inhibit environmental companies from pursuing overseas business. These uncertainties include issues related to culture, currency, insurance, ability to get paid, corruption, and more.

- The U.S. environmental industry is heavily populated with small and medium-sized companies that have little capability or inclination to export, especially when contrasted with those in Western Europe and Japan where many leading environmental firms are subsidiaries of well-capitalized parent corporations. This is particularly noticeable in equipment segments such as air pollution controls (in which U.S. entrepreneurs compete with companies such as the Swedish/Swiss giant ABB and Japanese conglomerate Mitsubishi) and in environmental infrastructure segments (in which U.S. companies compete with the large,

Table 10. ***Continued***

1996 U.S. Environmental Trade Balance

Equipment	U.S. Ind	U.S. Mkt	Surplus	Exports	Imports	%Exp
Water Equipment & Chemicals	17.5	16.0	1.5	3.3	1.8	19
Air Pollution Control	15.7	15.4	0.3	1.6	1.3	10
Instruments & Information Systems	3.1	1.8	1.3	1.6	0.3	51
Waste Management Equipment	12.0	10.7	1.3	1.9	0.6	16
Process & Prevention Technology	0.8	0.9	-0.1	0.0	0.1	1
Services						
Solid Waste Management	33.9	32.7	1.2	1.4	0.2	4
Hazardous Waste Management	6.0	5.9	0.1	0.2	0.1	3
Consulting & Engineering	15.2	14.2	1.0	1.3	0.3	9
Remediation/Industrial Services	8.6	8.3	0.3	0.3	0.0	3
Analytical Services	1.2	1.2	0.0	0.0	0.0	2
Wastewater Treatment Works	24.0	24.6	-0.6	0.2	0.8	1
Resources						
Water Utilities	26.4	27.0	-0.7	0.1	0.8	1
Resource Recovery	14.3	11.6	2.7	2.9	0.2	20
Environmental Energy	2.4	1.4	0.9	1.1	0.2	48
Total	**181.1**	**171.8**	**9.3**	**16.0**	**6.7**	**8.8**

Note: U.S. Ind is revenues generated by U.S. companies worldwide. U.S. Mkt is revenues from U.S. customers. Exports do not include ownership of overseas companies but do include repatriated profits.
Source: Environmental Business International, Inc., San Diego CA

privatized water companies from the United Kingdom and France). Developing overseas sales is expensive, and international business development costs are on the order of three to five times larger per dollar of sales than those in familiar, home markets. Investments on this scale are difficult for all but the largest 10% of U.S. firms.

- Inconsistent environmental laws and enforcement efforts from country to country (and region to region, county to county, and city to city) increase the risks and costs of doing business internationally (as well as in the United States).

- Lack of financing and access to hard capital for environmental projects inhibits many companies from pursuing international business, particularly in developing countries. Most U.S. companies are not accustomed to providing capital as well as their product or service.

- Geographic isolation is a factor. Firms in Germany and other European nations are located close to numerous markets with which they have historic business ties. Similarly, Japan has proximity to Asia's high-growth environmental markets. Ironically, the United States' largest neighboring market, Canada, actually exhibits a modest environmental trade surplus with the United States and certainly has a more aggressive strategy for expansion of Canadian environmental industry presence in the United States than U.S. firms have for Canada.

- A number of U.S. environmental firms have cited lack of government support in terms of business development, finance, "tied aid," etc., particularly compared with the government support their foreign competitors receive.

- Domestic market conditions play an underemphasized role in fostering or hindering the competitiveness of the environmental industry in both domestic and international markets. The United States' use of regulations to stimulate the environmental market has left many U.S. companies ill suited to compete effectively in international markets. Also, the decline of U.S. market growth has weakened the financial performance of companies, and many have curtailed expansion plans.

The United States' use of regulations to stimulate the environmental market has left many U.S. companies ill suited to compete effectively in international markets.

The privatization of water utilities and wastewater treatment works in several European countries is a useful example of how international business competitiveness can be improved. Companies from France and the United Kingdom have become by far the most internationally competitive for providing the integrated package of designing, building, managing, and even owning water infrastructure around the world. It is no coincidence that these companies have won major projects in Mexico, Brazil, Malaysia, Taiwan, and elsewhere. Privatization of the solid waste infrastructure in the United States has effectively made U.S. firms the international leader in this segment. The importance of the three environmental infrastructure segments of solid waste management, water treatment works, and water utilities cannot be overemphasized because together they represent about one-third of the U.S. market, 52% of the

$452 billion global environmental market, and well over 60% of the market in the developing world.

Overcoming barriers to export remains challenging, and each environmental industry segment has had varying degrees of success. Disparities in export proportions among U.S. environmental industry segments, as portrayed in the trade balance exhibits, is partially attributable to differences in domestic and international market demand, but also to relative competitiveness in the segment compared to other countries. Relative competitiveness on a subjective comparative scale is represented in Table 11.

The importance of the three environmental infrastructure segments cannot be overemphasized because together they represent about one-third of the U.S. market, 52% of the $452 billion global environmental market, and well over 60% of the market in the developing world.

Table 11. Relative Competitiveness of Environmental Industry

Equipment	U.S.	Germ	Japan	F & UK
Water Equipment & Chemicals	G	E	E	O
Air Pollution Control	O	E	E	M
Instruments & Information Systems	E	G	G	O
Waste Management Equipment	O	G	OG	O
Process & Prevention Technology	P	P	M	P
Services				
Solid Waste Management	GE	OG	M	OG
Hazardous Waste Management	G	O	O	O
Consulting & Engineering	GE	OG	M	O
Remediation/Industrial Services	G	O	M	OM
Analytical Services	G	O	O	O
Water Treatment Works	MP	M	MP	GE
Resources				
Water Utilities	P	MP	P	GE
Resource Recovery	O	OG	O	O
Environmental Energy	OG	OG	OG	M
Ranking	100	98	86	93

Source: Environmental Business International, Inc., San Diego, CA

E-excellent, G-good, O-OK, M-mediocre, P-poor, N-nonexistent

Based on ratings of technology, commercial orientation, management, finance, and global presence.

The United States has a distinct comparative advantage in service segments.

Relative competitiveness is ranked here not purely on technology, but also on private-sector orientation, management skills, technical personnel, financial clout, marketing skills, and other factors relating to the ability to sell and deliver work and systems. The United States has a distinct comparative advantage in service segments. One reason for this is that the U.S. economy is much more service based; many more of the functions of professional services (e.g., consulting, accounting, and legal) are outsourced rather than performed internally. For instance, environmental consulting represents 8% of the U.S. environmental market while it accounts for only 6% in Europe and less than 2% in Japan. Japan's advantage lies in the technology orientation of its leading firms, many of which are conglomerates with major engineering/construction and manufacturing units. Germany also exhibits a technology orientation, but combines it with more specialized companies. France and the United Kingdom are distinguished by their privately managed water systems. Each segment, however, has its own country story to tell.

1.6.1 Instrumentation

The United States possesses a noticeable competitive advantage in environmental instrumentation. It develops more advanced laboratory analytical equipment and monitoring devices, and its market requires more stringent analytics, particularly for hazardous substances. International markets in newly industrialized nations have emerging analytical and monitoring requirements, including increasing demand for analysis of toxic substances, as in other developed nations. U.S. environmental instrument manufacturers have generated over half of their revenues from outside the United States since 1994. Prospects for growth remain high as instrumentation is essential in both market-based and information-based environmental policy regimes. Future demand for instruments and environmental information systems is anticipated from adoption of more market-based policies, such as air emissions monitoring in tradable allowance programs and continuous water discharge monitoring for assessment of discharge fees. The use of environmental instruments and information systems also promises to fulfill somewhat the traditional role of regulatory agencies to the extent that monitoring systems replace inspections and information systems submit reports about compliance with permit conditions.

1.6.2 Water Systems

In water delivery and water treatment segments, the export contribution of U.S. companies is nearly nonexistent. Roughly 90% of the U.S. water infrastructure is owned and managed by public-sector companies. These companies are not organized as profit-making entities, and they lack

profit-based incentives for efficient management and adoption of innovative technologies. International business, which these companies do not pursue, requires all three. Large French and British companies that were privatized several years ago are now competing in the market for municipal services in developing nations. This momentum is accelerating the transfer of water infrastructure management and technology internationally. Not so apparent is that privatization of environmental infrastructure in developed nations will also lead to considerably more technology transfer with private interests behind it. It is no coincidence that French and British water companies have been the most internationally competitive businesses in developing water infrastructure markets.

Roughly 90% of the U.S. water infrastructure is owned and managed by public-sector companies.

1.6.3 Water Equipment

Competition in the sale of water treatment equipment has historically been keen and oriented to obtaining market share. Demand for water quality has been comparable across developed nations, leading to a similar competence in technology. The leading U.S. firms were acquired by foreign competitors in the early 1980s. U.S. firms have been catching up in the past 2 years thanks mostly to international acquisitions by the industry's leading players and by aggressive international expansion (e.g., Culligan and Osmonics). Companies making acquisitions overseas include US Filter (in Europe, South America, and Asia, as well as in the United States), Wheelabrator (Singapore), and Ionics.

1.6.4 Solid Waste

U.S. solid waste management firms have had much success bringing state-of-the-art disposal and collection systems to global solid waste markets because of business acumen that has been built in the privatized domestic market. Western European nations also have significant private-sector waste firms, but they do not match multibillion dollar U.S. leaders such as Waste Management and BFI. Japan's waste business, though large, is fragmented; no firm generates much over $100 million in revenues.

1.6.5 Consulting and Engineering

Environmental consulting and engineering firms export services in the form of problem evaluation, program and project management, engineering know-how, training, and design capabilities. This export of "knowledge and information" certainly can exhibit a multiplier effect in that engineering work is frequently the first stage of large construction projects and sometimes operations concessions yielding large revenue streams over time, as well as equipment sales. U.S. environmental consulting firms have been the most effective in world markets not only

because of their technical abilities but also for their sheer numbers. The United States boasts over 30 firms that perform more than $100 million in environmental consulting work annually, more than the rest of the world combined.

1.6.6 Hazardous Waste and Remediation

The relative emphasis of U.S. environmental policy on regulation, hazardous waste, and remediation has clearly stimulated the creation of the world's most technically competitive firms in the segments of hazardous waste management, consulting and engineering, analytical services, remediation, and instrumentation. To date, little of this capacity has been exported (with the exception of instruments), as market demand has not been nearly as high in other countries. Considerable interest in U.S. remediation technology has emerged from both Japan and Germany, however. These nations have tended not to remediate contaminated property as much as the United States and have used the "fences and signs" method much more than in North America. The United States does have considerable potential to leverage its expertise in site remediation, hazardous waste management, and possibly nuclear waste management in the more advanced markets.

1.6.7 Air Pollution Control Equipment

The history of air pollution control technology provides one final lesson in domestic market development. The United States passed the first comprehensive air quality legislation with the Clean Air Act in 1970. Regulations issued to implement the terms of this legislation and subsequent amendments effectively created the most competitive manufacturers of air pollution control (APC) equipment in the world in the United States. During the next 2 decades, while advances in U.S. APC regulations essentially foundered, Western Europe and Japan adopted early U.S. standards and almost universally exceeded them. Clearly, having greater concentrations of their populations closer to power-generating sources and the fact that these nations incinerate a significantly higher percentage of their municipal solid waste drove the advance in regulation. Meanwhile, while U.S. companies ramped up in response to Clean Air Act amendments, antiregulatory sentiment and weaker enforcement in the early to mid-1980s sharply reduced domestic demand. The business result was that technical and corporate development overseas in the APC segment soon overtook that of the United States. Manifestations of this transition included the purchase of the largest U.S. APC firm by ABB in the late 1980s and declining market share abroad and at home for U.S. APC firms. The final irony was that when regulations designed to meet the terms of the long-awaited Clean Air Act amendments of 1990 were

promulgated, the first installation of state-of-the-art APC equipment at an electric utility in Gary, Indiana, was Mitsubishi technology. The United States has had a persistent trade deficit in stationary source APC equipment and is noticeably less competitive in world markets.

1.7 Top 50 Environmental Companies in the World

Additional insight into the current competitiveness of environmental industries by nation can be gained from an examination of the top 50 environmental companies in the world. Companies in Table 12 are listed by parent company, nation of headquarters, environmental industry segment, and environmental revenues generated in 1995. It should be noted that some firms on the list have considerable revenues outside the environmental industry (Generale des Eaux, Asea Brown Boveri Corp., and Mitsubishi, for example), but a solid majority are purely environmental companies. A distinction worth noting is between the engineering construction segment and the consulting and engineering segment, the former performing mostly "back-end" or project implementation work, the latter performing mostly "front-end" or assessment and design work.

These top 50 companies represent $86.5 billion in revenues and 20% of the global market (up from $73.5 billion in revenues, or 18%, in 1994). A national breakdown of the leaders is revealing in segment orientation and its relation to the domestic market conditions in which the firms developed their business. The top two U.S. firms are solid waste firms that built their base of business on municipal waste hauling and disposal, and primarily through concerted acquisition campaigns of local and regional companies. The top two French firms based their business on private management of water utility and wastewater treatment operations mostly through privatization initiatives. All seven British firms in the top 50 emerged from England's sweeping privatization actions in 1989.

A national breakdown of the leaders is revealing in segment orientation and its relation to the domestic market conditions in which the firms developed their business.

All of the Japanese firms on the list are large manufacturers with a technology orientation. Little of the water infrastructure in Japan is under private management, and though considerably more of the Japanese waste infrastructure is, the vicissitudes of local relationships in Japan have limited the largest solid waste company to a $150 million share in a $20 billion market.

U.S. industry is obviously not alone in undervaluing the importance of developing its competitive position in the global environmental market,

U.S. industry is obviously not alone in undervaluing the importance of developing its competitive position in the global environmental market, but perhaps is alone in having the necessary information and perspective to structure and execute an appropriate strategy for leadership.

but perhaps is alone in having the necessary information and perspective to structure and execute an appropriate strategy for leadership. With $452 billion changing hands in the global market today, and another $100 billion to be added by 2004, the stakes remain high.

Table 12. Top 50 Environmental Companies in the World

	Company	Country	Segment	Env'l Revs* ($ billions)
1.	WMX Technologies	U.S.A.	Solid Waste/Diversified	10,250
2.	Generale des Eaux	France	Water/SW/Diversified	9,910
3.	Browning Ferris Industries	U.S.A.	Solid Waste	5,880
4.	Lyonnaise des Eaux	France	Water/Diversified	5,620
5.	Asea Brown Boveri Corp.	Switzerland	Diversified/Equipment	5,400
6.	RWE Entsorgung	Germany	Solid Waste	2,970
7.	Mitsubishi Heavy Industries	Japan	Incin/APC/Water Equip.	2,350
8.	Laidlaw Inc.	Canada	Solid/Hazardous Waste	2,270
9.	Ebara Corp	Japan	Water/Incin. Equip.	2,200
10.	Sabesp	Brazil	Water	1,960
11.	Philipp Holzmann	Germany	Solid Waste/EC	1,860
12.	Severn Trent	U.K.	Water/WW/C&E	1,690
13.	CGEA	France	Solid Waste (Generale)	1,620
14.	Noell Gmbh	Germany	APC/EC	1,590
15.	Jacobs Engineering Group	U.S.A.	C&E	1,469
16.	Bilfinger + Berger	Germany	EC	1,310
17.	Buderus	Germany	Diversified	1,280
18.	United Utilities	U.K.	Water/WW/Equip	1,210
19.	Hochtief	Germany	EC	1,210
20.	Linde	Germany	Equip/C&E	1,102
21.	Deutsche Babcock	Germany	Div/Equip	1,100
22.	SITA	France	Sol/Haz Waste	1,070
23.	Thames Water	U.K.	Water/WW Equipment	1,070
24.	VA-Technologie	Austria	Diversified	1,010
25.	Anglian Water	U.K.	Water	990
26.	Bechtel Group Inc.	U.S.A.	EC	902
27.	Kurita Water Industries	Japan	Equipment	900
28.	Rethmann	Germany	Solid Waste	890
29.	Degremont	France	Water Equipment	880
30.	Safety Kleen Corp.	U.S.A.	Hazardous Waste/Recycling	866
31.	ICF Kaiser International Inc.	U.S.A.	C&E	849
32.	American Water Works Co.	U.S.A.	Water	820
33.	GEA Pref.	Germany	EC	816
34.	Elyo	France	Waste Management	815

Table 12. *Continued*

	Company	Country	Segment	Env'l Revs* ($ billions)
35.	Yorkshire Water	U.K.	Water	795
36.	CH2M Hill Cos.	U.S.A.	C&E	753
37.	Nalco Chemicals Co.	U.S.A.	Water Equip/Chemicals	734
38.	Philip Environmental	Canada	Solid/Hazardous Waste	732
39.	Alba AG&Co	Germany	Solid Waste	730
40.	Thermo Electron Corp.	U.S.A.	Inst/C&E	728
41.	Ogden Corp.	U.S.A.	WTE/C&E	680
42.	Morrison-Knudsen Corp.	U.S.A.	C&E	678
43.	Air & Water Technologies	U.S.A.	Diversified	630
44.	Hitachi Zosen	Japan	Diversified	602
45.	Ferrailes, CF	France	Waste/Recyc	579
46.	Edelhoff AG&Co	Germany	Solid Waste	570
47.	Kubota	Japan	Equip	558
48.	Durr	Germany	Equip/IS	554
49.	Heidemij	Holland	C&E	540
50.	Black & Veatch	U.S.A.	C&E/EC	538
Total				**86,530**

*Company environmental revenues for 1995.

2. Forces Shaping the Industry

This chapter examines factors *outside* the environmental industry that are causing market conditions to change rapidly and that have had a significant effect on the business strategies of environmental companies. Among the most important factors, some of which have been introduced earlier, are those that affect the ability of U.S. industry to contribute to wealth creation in the United States and worldwide:

- ***Changing market motivators.*** Constantly changing market conditions have caused unusual uncertainties and complexities for environmental companies. For more than a decade, beginning in the early 1970s, new regulations stimulated markets and created strong business opportunities. Two difficult periods in the 1980s and 1990s, when enforcement policies appeared to slacken, led to significant market instability and reduced profitability. The addition of new environmental policy mechanisms to the traditional "command and control" system enlarged the criteria used for some environmental management decisions in the United States and abroad, changing the nature of some business opportunities for the industry.

- ***Customer approaches to environmental management.*** Within the United States and worldwide, both private-sector and public-sector purchasers of environmental products and services are exploring new ways to manage environmental and resource issues as a part of other core business decisions.

- ***Environmental regulations and other policies related to technology.*** Overall, current environmental regulations and policies discourage the development and deployment of new technology-based products and services that can strengthen the economy and benefit the environment.

- ***International environmental markets.*** U.S. companies face difficulties competing in a growing world environmental market in which the nature of demand is significantly different than in our home market, in which regulatory and economic policies vary considerably, and in which our competitors receive government support for exports.

Constantly changing market conditions have caused unusual uncertainties and complexities for environmental companies.

- ***Limited capital availability.*** The financial community's difficulties in gauging and managing investment risks in current market conditions have limited capital availability to all parts of the environmental industry. The industry is seeking ways uncertainties can be reduced and financial risks allocated more equitably.

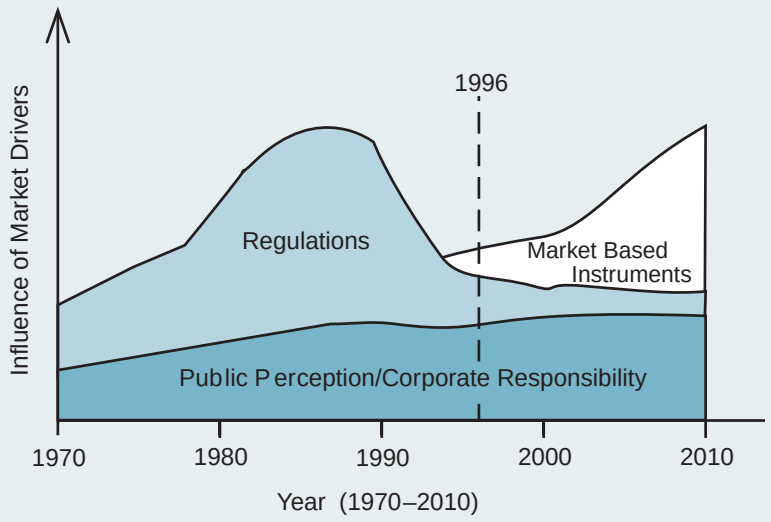
Figure 2 illustrates industry leaders' perspective about the changing influence of market forces over the past 25 years. It demonstrates the baseline of public accountability in environmental behavior, the ascent of the regulatory system in driving the market, and spending, which peaked in the late 1980s and into the early 1990s, and it shows the sharp drop-off in the effect of regulations on driving today's market. Nearly all environmental companies acknowledge the drop-off in demand, but their expectation for improvement in the future from market-based policy instruments, as portrayed in the chart, is the subject of speculation and some nervousness. Some firms still hold to the belief that more regulation will return.

While this may be true to a limited extent in niches (e.g., new regulations associated with recent amendments to the Clean Air Act), most firms are not anticipating a renewed pace of "command and control" regulations. Regulations will never be completely phased out as influences on the market, and the minimum standards they establish for environmental performance ensure at least minimal pricing for the environment and a cost baseline against which more creative environment-related investments can be gauged. Their relative influence will surely decline, however, as policies that apply economic mechanisms move to the forefront. The importance of implementing a steady flow of performance- and information-based policy instruments to drive environmental quality *with* a sustainably growing economy cannot be overemphasized, industry leaders say. As Figure 2 illustrates, these policy instruments offer the possibility of a return of growth and investment in the environmental industry and a healthy, win-win relationship between the environmental industry and the overall economy.

2.1 Evolving Conditions in U.S. and International Markets

Business conditions have changed rapidly over the 25-plus years of regulation-dominated environmental markets. Industry leaders have characterized their market as expanding in stepwise fashion, as statutory revisions created eras of business opportunity (e.g., the extension of wastewater treatment requirements to include secondary and tertiary

Figure 2. Changing Influence of Drivers Over Time



treatment for an increasing number of pollutants). They also note periods of contraction (e.g., the elimination of the Noise Pollution Control Act and two difficult periods when eased enforcement policies triggered business contraction throughout the industry). New or more stringent regulations and changed compliance tactics produced roller-coaster business cycles that were not caused by product development or competitive pressures from within the industry. New policy instruments stimulated strengthened market sectors in the United States and abroad.

New or more stringent regulations and changed compliance tactics produced roller-coaster business cycles that were not caused by product development or competitive pressures from within the industry.

Industry leaders note that these changes became apparent as several parts of the industry steadily transitioned from emerging, high-growth sectors populated by technically oriented firms to sectors characterized by high levels of competition, consolidation, and supply-and-demand imbalances that have made business exceedingly challenging. The impact of these factors is apparent. Many environmental companies now tend to move from problem to problem for their private clients and from program to program for their government clients, rather than accumulate and expand on a focused core competency. Their reactive approach has made companies fit to respond to the latest regulatory twist, but not able to thrive when environmental decisions are integrated with their customers' core business interests. Many firms do not see consistent financial criteria to validate investments in new technology, training of personnel, new information and management systems, new marketing initiatives, or

any investment that may put them and their financial security at risk in an uncertain market. Many companies now must contend with reduced competitiveness. Among the factors that contribute to this problem are the following:

- ***Slowed pace of new regulations.*** The system of market forces under which the environmental industry grew bred an industry that was responsive to the needs of clients, regulators, and others, a reactive industry waiting for the continually beating regulatory hammer to strike once again. Until 1991, this system sufficed to create a healthy business climate of growth and strong demand. A stairstep growth of regulations seemed to deliver endless environmental problems to address and a stairstep growth of regulations to which to reply, although enforcement seemed to wax and wane. But as the push for environmental programs and regulations eased and simultaneously the economy entered a recession in 1991–1992, the environmental business rapidly changed. Many industry leaders say it is now clear to them that the era of widespread environmental industry growth dependent on government action has drawn to a close in the United States. Most regulatory issues such as reauthorization of the Clean Water Act, Superfund, the Resource Conservation and Recovery Act, and other laws were unresolved in 1997. A growing percentage of companies realize that they need strategic options for operating in a business climate less dominated by regulation.

- ***Inconsistent enforcement.*** In the uncertain market of the late 1990s, selling environmental work purely on the merits of compliance carries reduced weight. On one hand, much of the most obvious work has been done: Water and air quality, for instance, are better today than they were 20 years ago, and a large majority of regulated parties are in compliance. On the other hand, the perceived risks of noncompliance are considerably less than in the past. Selling environmental work solely on "return on investment" (ROI) is likewise difficult in the absence of the threat of substantial penalty for malfeasance. When the environment is "free," and when there is no assurance that competitors will face risks for noncompliance, regulated parties place themselves at a disadvantage if they alone incur environment-related costs. Thus, industry leaders are adamant that steady enforcement is essential to their market.

Part of the ROI calculation on environmental expenditures by the regulated community must be the benefits of avoiding the costs of waste disposal, administrative expenses, enforcement actions, and legacy liabilities. Then, savings from material and energy costs, process efficiencies, recovered resources, as well as market share gains owing to favorable public perception can be added to the equation. The combination of regulatory cost avoidance and savings from new, efficient solutions can be decisive.

- ***New types of policies and regulations that strengthen the market.*** Policy changes have begun to encourage such positive thinking. Industry leaders particularly note information-based requirements, such as the Toxics Release Inventory (TRI) and tradable emissions credit programs, as being among the best examples
so far. They also note, however, that there is a long way to go before the reforms are systemic, multimedia, and long lasting.

  Tradable credits have gone the farthest in engaging the market to stimulate environmental improvement and investment in the United States, although not always to stimulate demand for environmental companies. The sulfur dioxide (SO_2) program provides a case in point. Utilities in the Northeast—which do not have to comply with Maximum Available Control Technology (MACT) standards as defined by the EPA, which have been allowed to reduce emissions in their own way, and which have been given incentives to go beyond compliance—have seen considerable savings and improved air quality. They have switched to low-sulfur coal, rather than install additional emissions controls. An analysis performed by the Environmental Law Institute[7] on behalf of EPA shows that a collective investment of less than $2 billion to extend railroads into Wyoming and Montana to transport low-sulfur coal to Eastern markets avoided a cost of over $5 billion in additional emissions control systems. The $5 billion would have been necessary if higher sulfur Eastern coal was still used. The change accrued from the use of cheaper coal ($16 per ton from Wyoming compared with $28 per ton from West Virginia, including transportation, for example) and more efficient combustion in the boilers.

The combination of regulatory cost avoidance and savings from new, efficient solutions can be decisive.

[7] Environmental Law Institute, *Barriers to Environmental Technology Innovation and Use*, Washington, DC, January 1998, and interview with principal author, Byron Swift, May 1996.

While the U.S. experience in market-based instruments is still limited, countries around the world are pioneering their use.

- ***Increasing use of market-based policies in international markets.*** While the U.S. experience in market-based instruments is still limited, countries around the world are pioneering their use. From tradable pollution permits (United States, China, Poland) to tradable water shares (Australia, India) to tradable reforestation credits (Costa Rica) to carbon offsets (Malaysia, Guatemala, and others) to watershed charges (Costa Rica, Indonesia, Brazil) to overcompliance credits combined with undercompliance penalties (Germany, China) and many others, a critical mass of market-based instruments is being assembled around the world. Resulting environmental improvement and the beginnings of an economic framework for environmental policy are not far behind, and by all accounts this will be positive for both the environment and the economy.

  A 1996 meeting of the Third Expert Group on Financial Issues of Agenda 21, organized by the United Nations Department for Policy Coordination and Sustainable Development,[8] foreshadowed increasing use of environmental policies shaped by economic instruments. Chairman Lin See-Yan of Pacific Bank (Malaysia) concluded, "Policies must increasingly shift toward economic instruments to stimulate dynamic private-sector involvement in both the supply and demand sides of environmental investments." The meeting also included a presentation by the director of the Harvard Institute for International Development, Theodore Panayotou, of a matrix of more than 100 policy options using financial instruments, with working examples of over half of these innovative policy instruments.

2.2 Evolution of Customer/User Approaches to Environmental Management

Most customers of the environmental industry improved their environmental management practices as a general response to public outcry against widespread environmental degradation. Their specific pro-environment actions responded to regulations instituted in the United States beginning in the 1960s and, especially, the 1970s and 1980s. Purchase of the environmental industry's products and services enabled this

[8] United Nations Department for Policy Coordination and Sustainable Development, *Report of the Third Expert Group Meeting on Financial Issues of Agenda 21*, New York, NY, February 1996.

progress. Meaningful regulation established a relatively level "playing field" *within the United States* in which all organizations have to invest to improve environmental performance, and no significant polluters can use the environment without cost. The costs associated with environmental protection in the increasingly *global* economy, however, weigh unevenly.

Leading corporations that integrate environmental and other business decisions internally have now shown that environmental protection is not necessarily an expense without positive return, and that competitive advantages can accrue from creative approaches to environmental management. In other words, they have shown that investments in environmental protection can yield win-win solutions that improve both competitive *and* environmental outcomes. More and more environmental companies recognize that opportunities exist to offer a wide variety of new products and services. They are finding that opportunities are growing to build long-term relationships with customers that practice the paradigm of continuous improvement. In turn, their customers are finding that the public appreciates good "corporate citizenship."[9]

Corporations that integrate environmental and business decisions have shown that environmental protection is not necessarily an expense without positive return, and competitive advantages can accrue from creative approaches to environmental management.

The ability to make statistically based measurements of these trends is made difficult by the general lack of survey information. Two academic studies[10] from a Carnegie-Mellon/Harvard team led by Richard Florida provide the only such databases. One study focuses on large public companies in the United States. The other focuses on Japanese-affiliated manufacturing companies, or "transplants," that operate in the United States. Recent papers from the two studies contain the results of a survey of several hundred manufacturing firms.[11] In addition, the Department of Commerce (DOC) Manufacturing Extension Partnership (MEP) is developing information about the environmental strategies of smaller companies, but comprehensive data are not yet available. Initial results show, unsurprisingly, that the strongest incentive for these companies to reduce

[9] Richard Florida, "Lean and Green: The Move to Environmentally Conscious Manufacturing," *California Management Review*, volume 39, number 1, fall 1996, pages 80–105.

[10] Florida, *op. cit.* Another is Paul Davis Jenkins' Ph.D. dissertation, *The Japanese Transplants and the Work System Revolution in U.S. Manufacturing*, Carnegie-Mellon University, 1995. The latter study was also reported in 1995 to the Sloan Foundation, its sponsor, by Richard Florida: *The Japanese Transplants Project: Final Report to the Sloan Foundation.*

[11] Florida, *op. cit.*, page 97. This paper contains findings from what is probably the first statistically based study to document the widespread and growing use of environmental solutions that simultaneously improve environmental and industrial performance by larger U.S. firms. The author's survey included 450 manufacturing firms. These were drawn from public companies (250 firms

pollution is the need to comply, and that nearly half see opportunities to improve their profitability through effective pollution prevention. Most of the smaller companies do not use outside environmental services, other than for basic infrastructure needs. MEP provides services designed to help small manufacturers improve the competitiveness of their productive processes and their environmental performance. Companies eligible for MEP services are too small to be included in the Carnegie-Mellon/Harvard work.

These two Carnegie-Mellon/Harvard papers observe that changes in environmental decision-making processes "may be a consequence of unrelated corporate efforts to improve quality, reduce cost, and/or increase performance rather than from a directed and strategic effort to achieve joint gains in industrial and environmental performance." Regardless of the purposes of these efforts, these business units have the opportunity to benefit from cost savings and, indeed, from a wider range of solutions to environmental problems, including those in which environmental problems are avoided and environmental solutions are built into production processes and product designs. Some of these solutions can increase resource efficiency and productivity, reduce liabilities, improve products, and therefore boost competitiveness. They also allow the environment to be viewed as an opportunity, rather than merely as a cost. The authors found that more than 75% of firms in the large-firm study employ source reduction, recycling, and production process improvements as main elements of their environmental strategies.

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in the S&P 500 Index, 100 mid-size firms from the S&P Midcap Index, and 100 small firms from the S&P Smallcap 600 Index). Two methodological aspects of the study bear mention. First, neither firms with market capitalizations of under about $100 million nor privately held firms were included in the survey. As a result, the study could not determine whether the same trends in environmental decision making can be seen in smaller, less technically competent firms. It is also notable that the terminology used in this study is different in important ways from that used by the National Science and Technology Council, the Environmental Protection Agency, and other federal agencies. Specifically, these agencies use a narrower definition of the term "pollution prevention" than the Florida study. The federal agencies do not include recycling, pollution control technologies, or treatment of wastes in their definition. Results from the Florida study that indicate a very high use of pollution prevention must be tempered to a degree to take into account these definitional differences. Nonetheless, the study makes an important contribution in documenting for the first time the shift of corporate environmental strategies.

This recent work[12] establishes the validity of several important and relevant observations, at least for larger firms, including a statistical link between "environmental and industrial strategy and performance." Florida's findings, along with anecdotal findings by other researchers, point the way to future strategies for both the environmental industry and government. His observations lend "considerable support to the hypothesis that adoption of innovative environmental practices is an element of a more general strategy of productivity-enhancing manufacturing process improvement on the part of firms." The following observations are drawn from Florida:

- Many of the industry's customers are "leveraging their industrial modernization strategies for environmental ends," and they do this to "considerably reduce emissions in ways that simultaneously enhance their productivity."

- "There is a close relationship between green design and R&D spending, product innovation, and a range of advanced manufacturing practices—including employee involvement in continuous manufacturing process improvement and close supplier relations."

- Companies are expanding the range of factors that are foremost in determining their environmental strategies. The newly included measures are "associated with industrial performance" (especially "technological improvements, customer demands, and productivity improvement") as well as traditional "environmental requirements and corporate citizenship."

- "Close relationships across the production chain—and between end-users and suppliers in particular—facilitate the adoption of advanced manufacturing practices, creating new opportunities for joint improvements in productivity and environmental outcomes." And, "environmental improvements flow from ongoing efforts to improve productivity, eliminate defects, and reduce costs, rather than from direct efforts to transfer pollution prevention technology or organization strategies designed expressly to eliminate toxins or prevent pollution."

Adoption of innovative environmental practices is an element of a more general strategy of productivity-enhancing manufacturing process improvement on the part of firms.

[12] Florida, *op. cit.* Dr. Florida and his colleagues, who include Dr. Davis Jenkins and Dr. Atlas, have published several papers. Florida's primary conclusions in the current study, which are quoted here, appear on page 100 of the *Review*. Florida's work was sponsored by the National Science Foundation and other organizations.

The environmental industry serves two broad classes of customers: private-sector companies and public-sector entities.

2.2.1 Private-Sector Customers/Users

The environmental industry serves two broad classes of customers: private-sector companies and public-sector entities. While all have been motivated in large part by the need to comply with environmental regulations, private companies also must compete with others in their own industries, making them highly cost conscious in comparison with public-sector customers.

The *traditional* private-sector response to the "command and control" paradigm has brought U.S. environmental performance from deplorable to acceptable. Environmental management practices are changing, though, and these changes have major implications for future demand for environmental products and services. The new approaches enable excellence in environmental performance, contingent on greater cooperation between government and the environmental industry, and on greater collaboration between the industry and its customers.

Over the past 25 years, the preferred tools of *traditional* environmental management strategies in the private sector have been end-of-pipe pollution controls. This approach to environmental management began as a response to public demand, enforced by laws and regulations, for cleaner water and air and for safer practices for waste management. Early governmental interventions, in the main, established source-specific pollution limits based on existing control devices and, in effect, prescribed specific solutions. This method of intervention, which is dominated by regulations, administrative process, specifications, and enforcement, is widely known as "command and control." It offers little flexibility, administratively or with respect to required outcomes and methods, and violations result in fines and other penalties to the polluter. Rewards are not available for companies that go beyond required compliance. Thus, the primary motivators of environmental performance have been public demand and the need to comply with environmental laws and regulations.

Observers of polluters' responses to the environmental issue have, in varying ways, noted two evolutionary approaches. These may be termed *transitional* and *advanced*.[13] The traditional approach predominates; as yet, only a small percentage of firms employ the advanced approach. The

[13] Florida and Davis Jenkins use slightly different terms in describing the types of manufacturing systems employed by different companies, referring in their fall 1996 paper to "Taylorist," "transitional," and "advanced" manufacturing systems. In its October 1992 report, *Improving Technology Diffusion for Environmental Protection* (#EPA 130-R-92-001), page 33, the Environmental

three approaches (see Appendix A), by whatever descriptive terms they are known, involve varying corporate strategies related to (1) factors considered in environmental decision making; (2) location in the corporate structure of environmental decisionmakers, (3) inclusiveness of decision-making processes within customer organizations; and (4) participation of outside organizations, particularly suppliers and customers, in decision making.[14]

Factors Influencing Approach to Environmental Management

All three approaches to the management of environmental affairs are in use today, as each organization independently judges the advantages and disadvantages of each. The traditional approach draws its motivations from laws and regulations; liability; public opinion; and a desire to improve environmental, safety, and health performance. The primary environmental goal of companies taking the traditional approach is to comply with applicable environmental regulations, thereby avoiding the risks of noncompliance. Companies that begin evolving the basis for their environmental approach still draw their motivation from public demand, federal and state laws and regulations, and liability concerns. They weigh more heavily, however, the expectations of external stakeholders (e.g., the financial community, customers, suppliers) and the public (as reflected in their reputation), as well as the expectations of their employees.

In the transitional and advanced approaches, companies adopt a second set of motivators for environmental management strategy. This set of motivators is tied to both the efficiency of their operations and external expectations. While regulatory requirements establish minimum levels for compliance, these companies respond increasingly to customer expectations, market opportunities, external stakeholders, and their concern about protecting their public reputation. This set of motivators closely parallels the drivers of their *overall* business strategies—market opportunities, customer expectations, and demands of external stakeholders that fuel competition in the marketplace—for which efficiency, productivity, and public reputation are major measures. These ap-

In the transitional and advanced approaches, companies adopt a set of motivators tied to both the efficiency of their operations and external expectations.

Protection Agency administrator's external policy advisory committee on technology, the Technology Innovation and Economics Committee, referred to "leaders," "followers," and "laggards" (in reverse order to Florida and Jenkins), conveying a valuation to companies' commitment to environmental management. Whatever labels are used, it is valuable to examine differences in the key variables that reflect companies' approaches to environmental management, including priority, environmental decision-making process, type of solutions employed, organization, accounting practices, and worker participation.

[14] Florida, *op. cit.*

proaches are already having a significant impact on business operations within *leading* companies in many industries, where its use appears to be well established.

Trends in Private-Sector Environmental Management

Today, the marketplace for environmental products and services is changing in response to intensifying economic and other pressures, as well as a perception of eased enforcement policies. The need to improve environmental outcomes from business activities, however, is still primarily driven by regulations. Many companies have found additional motivations for changing their decision-making processes and have reflected these new motivations in their choice of approach to environmental management. Some of these motivations have gained importance to the point that in a small but growing number of cases, they are of nearly equal importance to regulations. These motivations are varied, and some are complex, but in general they fall into three broad categories:

Today, the marketplace for environmental products and services is changing in response to intensifying economic and other pressures, as well as a perception of eased enforcement policies.

- ***Competitive pressures.*** Intense economic competition generates the need to make mutually reinforcing improvements in productivity and environmental outcomes. Many of these improvements convey competitive advantages, as well as regulatory compliance.

- ***Marketplace demands.*** The market for goods and services increasingly demands sound environmental practices. This demand is a product of (1) customer demand for "green" products, and (2) customers' adverse reaction to corporate environmental mistakes. For example, consumers have relaxed their demand for the whitest paper to the point that recycled paper, which is off-white, has gained a significant market share. The demand for organic vegetables and meat has grown to several billion dollars a year in less than a decade. In addition, a number of companies have suffered significant losses of market share after they were linked to major environmental disasters (e.g., Exxon, after the Valdez disaster).

- ***Legal and institutional pressures.*** These include a changed body of common law (e.g., tort liability); changed Financial Accounting Standards Board (FASB) accounting standards and Securities and Exchange Commission (SEC) requirements that require companies to divulge and create capital reserves for environmental liabilities; and increased attention to environmental liabilities in the investment community. Together, these factors have changed

the legal and financial accountability for companies' impacts on people and the environment.

The relative importance of these factors varies by industry and by company. Few companies and few industries, however, are immune to these shifts, and the impact of them is accelerating change in the environmental industry's products and services.

To take advantage of opportunities for environmental and efficiency gains, more and more of the industry's customers are demanding flexibility from regulators concerning *how* they meet environmental requirements. These firms are asking to be gauged by their environmental performance, rather than by their adherence to administrative process and their conformance with regulatory guidelines. The most advanced are seeking this flexibility to gain efficiency and control in their businesses, manage environmental resources for maximum effect, and meet customer, stakeholder, and public expectations. The need to reduce environmental costs and become more efficient producers has thus become an important factor of marketplace competition in several industries. This factor presents new opportunities and challenges for the environmental industry.

More and more of the industry's customers are demanding flexibility from regulators concerning how they meet environmental requirements.

Several new tools encourage customers of the environmental industry to choose the transitional or advanced approaches for environmental management. These include the following:

- Corporate responsibility programs (e.g., the Responsible Care program in the chemical industry).
- Quality-based strategies (e.g., ISO 14000).
- New accounting strategies (e.g., SEC-required reporting of environmental liabilities, FASB accounting standards).
- Regulations that focus on performance (e.g., facilitywide permits, economic instruments such as marketable permits).
- Environmental disclosure policies (e.g., "green" labels and the TRI).

A major factor in the reshaping of environmental demand is the growing number of private-sector customers reexamining the origins of, consequences from, and alternatives to historic practices that cause environmental harm. These companies have seen that waste and pollution

These companies have seen that waste and pollution reflect inefficient use of resources and are a financial drain, dangerous to their employees, and a source of corporate risk.

reflect inefficient use of resources and are a financial drain, dangerous to their employees, *and* a source of corporate risk. Some companies have concluded that even minor changes in product design, materials specifications, or production processes can yield such important benefits as increased efficiency, reduced waste and waste disposal costs, lowered environmental permitting and compliance costs, increased worker safety, improved response to market opportunities, reduced future liabilities, and increased company profits. Many products can be repositioned to take advantage of expectations for "green" products. For example, Arm and Hammer gained market share by changing its marketing strategy to emphasize the environmental advantages of its products, and Proctor and Gamble increased sales by introducing products and packages that could be viewed as environmentally sensitive.[15]

The search for opportunities to make process and product changes that reduce environmental costs and increase competitiveness is becoming more widespread. Although compliance with regulatory requirements continues to be most companies' environmental goal, the search is expanding for environmental solutions that convey competitive advantages over baseline solutions. These solutions range from incremental to systemic. The advantages of these solutions is often diminished, however, by current environmental regulatory policies that make the advantages difficult to secure or that fail to reward environmental behavior in excess of regulatory minimums.

A number of companies have found customers for their expense-generating wastes, turning them into byproducts that have value. Pollution prevention and the recycling of spent products are at the heart of the concept of *industrial ecology.* As defined in *Technology for a Sustainable Future*, industrial ecology is "the study of a closed loop in which resources and energy flow into production processes, and excess materials are put back into the loop so that little or no waste is generated. Products used by consumers flow back into production loops through recycling to recover resources. Ideally, the loops are closed within a factory, among industries in a region, and within national and global economies."[16] Some observers have commented that industrial ecology

[15] James Maxwell, Lola Matysiak, Jennifer Nash, and John Ehrenfeld, "Preventing Waste Beyond Company Walls: P&G's Response to the Need for Environmental Quality," *Pollution Prevention Review*, summer 1993.

[16] National Science and Technology Council, *Technology for a Sustainable Future*, Office of Science and Technology Policy, Washington, DC, July 1994, page 54. Page 54 contains a graphic that describes industrial ecology. Page 55 contains a graphic that represents the approach to industrial ecology in a city in

sometimes appears to focus more on waste and spent product recycling than on industrial efficiency and the prevention of pollution.

Some companies have recognized that the cost and difficulty of treating complex waste streams can be greater than the cost of treating the same wastes separately. The complexity and expense of industrial wastewater treatment plants, for example, increases if they process a mix of wastes rather than treat waste streams separately. Now, some companies store categories of waste separately, install separate waste lines, and treat wastes individually. This tactic has gained a name, *source reduction*, and many adherents. For example, when General Motors (GM) built the first Saturn plant, subslab drain lines were intentionally left out of the design to keep solvents out of the wastewater altogether. As a result, the company reported that the cost of building the plant was reduced, the plant's liquid wastes became easier to treat at its wastewater treatment plant, the use of solvents dropped well below expectations, the amount of hazardous wastes produced at the facility was lower than at comparable GM plants, and even the use of cleaning rags dropped. GM has indicated that this design innovation led directly to a cleaner work ethic by the factory's employees.

Environmental optimization usually expands to changes—incremental or systemic—in production processes. For example, one raw material may be substituted for another, changing a waste stream from a regulated hazardous waste to a nonhazardous waste. This action may not have been advantageous at first glance. But the decision may have become clear when both environmental and productivity factors were considered together. Companies increasingly take advantage of supplier suggestions or lessons learned from benchmarking to find opportunities for such incremental changes.

Some companies have recognized that the cost and difficulty of treating complex waste streams can be greater than the cost of treating the same wastes separately.

Denmark, Kalundborg. The graphic was taken from a paper by Henning Grann, "Potential for Industrial Symbiosis Based on the Kalundborg Experience," which was presented at the National Academy of Engineering's International Conference on Industrial Ecology, Irvine, CA, May 9–13, 1994. Another useful paper on industrial ecology is by John Ehrenfeld of MIT, "Industrial Ecology: A Strategic Framework for Product Policy and Other Sustainable Practices," *Green Goods 5*, Kretsloppsdelegationens Rapport, Stockholm, 1995.

A number of companies actively seek to turn environmental liabilities into competitive advantages by integrating environmental planning into both strategic and day-to-day business decision making.

A case study[17] written by a Massachusetts Institute of Technology (MIT) team documents the story of one company. MIT confirmed that by including *all* production-related costs (product-related plus total process-related environmental costs) in its business calculus, the owners of one Massachusetts electroplating firm could calculate the opportunity of investing in a new production process rather than purchasing an expanded wastewater treatment system needed to achieve compliance for its existing production process. This opportunity would not have been apparent without an enriched decision-making process. Without the change the company would have been a higher cost producer than its competitors and may have become uncompetitive.

A number of companies have expanded the search for new options to the point that they actively seek to turn environmental liabilities into competitive advantages by integrating environmental planning into both strategic and day-to-day business decision making, co-optimizing environmental outcomes with other factors. The competitive advantages these *advanced* firms seek include regulatory compliance with reduced cost for environmental management, improved public and community relations, better customer relations, improved management of raw materials, use of production-related technology advances, productivity gains, and greater internal control of their businesses. The firms most likely to initiate this step independently[18] are usually large and technologically sophisticated industry leaders that are adopters of advanced processes for improving economic and environmental performance. The 3M Company, for example, is well known for its efforts to remake the processes it uses in manufacturing adhesive tapes, shifting manufacturing from solvent-based processes to cleaner water-based processes. Water can be recycled within the manufacturing process, maintaining product quality while significantly reducing pollution-related costs.

One of the fastest growing tools that encourages and enables advanced or strategic business and environmental management practices is ISO 14000.[19] ISO 14000 enables systematic, companywide, responsible envi-

[17] Michael Berube, Jennifer Nash, James Maxwell, and John Ehrenfeld, "From Pollution Control to Zero Discharge: How the Robbins Company Overcame the Obstacles," *Pollution Prevention Review*, spring 1992.

[18] Florida, *op. cit.*, pages 91–100.

[19] For a review of the role of ISO 14000 as a market driver for the environmental industry, see the *Environmental Business Journal*, January 1997, article by Ira Feldman, g&t strategies, Washington, DC. See also www.earthvision.net for business information on ISO 14000. Many environmental consulting firms have developed expertise related to ISO 14000 certification.

ronmental management. Because ISO 14000 offers a methodology for integrating environmental factors into company decision making, companies that employ ISO 14000 are more likely to identify environmental problems, to be in compliance with environmental requirements, and to deploy creative solutions to environmental problems. The use of ISO 14000 as a key part of acceptable environmental management practice is gaining formal recognition from regulators outside the United States, and therefore, this process will be an international competitiveness factor. Within the United States, ISO 14000 has not gained wide regulatory recognition. A growing number of U.S. companies use one or another form of strategic environmental management, however.

Changes in Demand Resulting From Trends in Customer Industries

The use of improved processes for environmental decision making by private-sector customers changes the nature of the products and services demanded from the environmental industry. These include a greater demand for the following:

- ***Lower cost services.*** As companies recognize the total cost of the environmental products and services they use, they more actively seek ways to reduce cost without sacrificing compliance, overall environmental result, or corporate image.

- ***Multimedia, or integrated, environmental services.*** For many companies whose understanding of their environmental problems has grown, it has become attractive to obtain total environmental support from a single, large service provider. This solution simplifies the customer's management of environmental products and services and allows a closer and more comprehensive relationship to develop, with greater sharing of confidential business information aimed at increasing efficiency and lowering costs. This solution also helps avoid situations in which solving one problem (or reducing its cost) causes another environmental problem elsewhere (or increases the costs of managing another problem). The problem of "crossmedia shifts" in pollution is well-known; for example, reducing an air pollution problem by using a bag house or a scrubber can generate a sludge that causes a solid waste, hazardous waste, or water pollution problem. Integrated environmental management can often reduce shifts, reduce pollution-caused risk, and reduce costs.

The use of improved processes for environmental decision making by private-sector customers changes the nature of the products and services demanded from the environmental industry.

Companies demand latitude to choose how they will gain compliance and reduce other environmental liabilities.

- ***Wider range of products and services.*** Now, as before, companies demand environmental products and services that achieve compliance or other environmental objectives. More and more are also looking for environmental solutions that offer other competitive advantages (e.g., higher productivity, reduced waste of process energy and material inputs, greater in-process reduction of environmental residuals, and "greener" products).

- ***Services that provide an assured outcome.*** The greater a company's understanding of its environmental problems and the possible solutions to them, the wider it will search for environmental providers that can ensure environmental and worker safety, compliance, and an avoidance of future liabilities. Moreover, reliability is vital to the high percentage of companies—within the United States or internationally—for which business operations are dependent on the day in and day out performance of environmental technologies. A production stoppage can be more expensive than the penalties associated with short-term noncompliance or even the extra costs from using less advanced but tried-and-true environmental solutions.

- ***Independence to choose environmental solutions.*** The more companies understand the origins and costs (short and long term) of environmental problems, the significance of each problem, and the possible ways to both solve them and increase competitiveness, the more they demand latitude to choose *how* they will gain compliance and reduce other environmental liabilities. For environmental companies, this means that their customers will demand a wider range of products and services. This shift in demand has great implications for environmental regulators accustomed to "command and control."

2.2.2 Public-Sector Customers of the U.S. Environmental Products and Services Industry

As discussed in Chapter 1, public-sector authorities are the source of roughly one-third of the U.S. environmental industry's revenues. Two types of public-sector authorities—including agencies at all levels of government—are customers of the environmental industry:

- ***Environmental service providers that are state, regional, and local governmental authorities.*** Individual public authorities traditionally provide one or more of four types of environmental infrastructure services to companies and the public: potable water,

wastewater treatment, solid waste management, and resource recovery. Collectively, they are the primary providers of wastewater treatment and potable water in the United States, and many also issue permits and take enforcement actions related to environmental problems, particularly with respect to their customers that discharge liquid effluents into their wastewater systems. They remain among the leading providers of solid waste management services, although private companies now provide these services to more than two-thirds of Americans. These authorities are both a part of the environmental industry and customers of it. Public-sector authorities also continue to be significant providers of postconsumer recycling services, with private-sector companies still generating more than 75% of total revenues from sales of postconsumer and postindustrial recycled materials. These environmental service providers have revenues that total more than $60 billion, and their purchases of products and services from the environmental industry is about $25 billion, not including permit fees and penalties.

These public sector environmental service providers have revenues that total more than $60 billion, and their purchases of products and services from the environmental industry is about $25 billion, not including permit fees and penalties.

- ***Federal, state, and local agencies that are stewards of public resources or regulatory organizations.*** Agencies that serve as stewards (e.g., facilities, lands, or other resources) are the source of most of the remainder of industry revenues contributed by public-sector authorities. The remediation of environmental problems associated with these public resources contributes the largest share of these revenues, and the management of stewardship contributes much of the rest. Regulatory organizations also purchase services and products from the environmental industry, the largest amounts from the consulting and engineering and the analytical services segments of the industry. Regulatory agencies develop environmental regulations, administer regulatory processes such as permitting, compliance, and enforcement actions, and provide technical assistance and information. These stewardship and regulatory agencies administer and manage Superfund sites (EPA, state EPAs), manage water resources for much of the United States (Army Corps of Engineers, Coast Guard), oversee management of environmental problems at the weapons complex (Department of Energy), manage large amounts of land (departments of the Interior, Agriculture, and Defense), and are the landlords of thousands of buildings (departments of Defense, Energy, and Interior; the General Services Administration; state and local governments). Other federal, state, regional, and local authorities also administer environmen-

tal regulatory programs. These agencies spend about $15 billion for the full range of products and services provided by the environmental industry. Federal agencies are the predominant customer for site remediation services in the United States and are a major customer for consulting and engineering services.

Trends in Public-Sector Environmental Management

Both of the above types of public-sector environmental management organizations are in flux.

Environmental service providers in the public sector. Outside factors are compelling two major related trends affecting the four types of environmental infrastructure services. First, the public's willingness to pay increasing costs for the services government provides is declining, even while support for environmental protection remains high. Second, the status of environmental authorities as public-sector organizations is in flux.

Budgetary constraints and philosophical trends are reshaping public environmental services. The electorate across the country now demands that services traditionally provided by the government be more efficient and cost less. People are questioning traditional roles of government and talking about downsizing it. Governments are responding in many parts of the country by seeking ways to reduce the capital and operating costs of *all* types of services, particularly less visible infrastructure. For example, private companies perform most street construction and repairs, and the charter school movement is reshaping many public schools. Voter unwillingness to increase public fees and taxes has squeezed the revenue base for government-operated environmental authorities. Increases are being resisted for all types of public debt—the main source of capital for public authorities—including general obligation, industrial revenue, and public improvement bonds. With diminished borrowing ability and fairly stable revenues, the managers of public authorities have had to look to other solutions to finance capital improvements and pay for operating costs. Increasingly, communities are examining or undertaking institutional separation of environmental authorities (i.e., the reorganization of authorities as government-related corporations) and even privatized management or ownership of environmental services. These trends are affecting environmental services provided by government authorities: 67% of solid waste management service revenues are now generated by private companies. Forty years ago, only about 10% of the solid waste business was in private hands.

The electorate across the country now demands that services traditionally provided by the government be more efficient and cost less.

Privatization came first to solid waste management. Two primary factors led to this shift in the management of solid waste:

- ***Service charge formulas that are "fee based," not "use based."*** Solid waste management charges for single family residences have typically been billed at a flat rate (usually paid with real estate taxes), with the fee, or rate, staying constant regardless of the amount of waste generated. In "use-based" billing, charges are for specific services used (e.g., number of bags or cans of trash left for curbside pickup, number of gallons of potable water passing through a home meter). Some communities have shifted to use-based charges—usually in an attempt to reduce the amount of waste collected—to extend the lifetime of existing landfills or to address the difficulty of locating (and the greater costs for new) sanitary landfills. Simultaneously, public resistance to incineration has reduced that option for solid waste disposal.

- ***Labor costs that are a higher fraction of the total costs for solid waste management and recycling than for wastewater treatment and potable water supply.*** By substituting private companies for public agencies, communities reduced labor costs to obtain greater flexibility in work rules and, in some parts of the United States, lower wage scales. Capital costs are a higher share of total cost for other environmental services.

As a result of financial pressures on state and local government, the privatization trend for environmental service authorities may extend to wastewater treatment and potable water supply in coming years. (Public concern that communities will no longer directly control their own water supplies may slow this trend, as well as certain tax code disincentives that suppress privatization.) Privatization could trigger transactions totaling hundreds of billions of dollars and could result in the shift of the management or ownership of major public infrastructure resources to the private sector.

As a result of financial pressures on state and local government, the privatization trend for environmental service authorities may extend to wastewater treatment and potable water supply in coming years.

The impact on the environmental industry may be relatively slight, at least at first, as private-sector operators of wastewater and potable water infrastructure must turn to the same suppliers. In a rapidly consolidating business environment, however, vertical integration may occur; the *operators* of U.S. water supplies may become one and the same as the *equipment suppliers* (e.g., the French and British companies), as technological advantage becomes a critical competitive factor. In the longer run, this shift could result in major opportunities for supplier industries as the new operators seek to modernize and gain efficiencies with new technological solutions and as consolidation in a growing market leads to higher valuations.

Little statistical information exists about the operating practices of public-sector environmental service providers. As a result, it is not possible to state other than anecdotally that public-sector environmental entities are adopting improvements that lead to simultaneous productivity and environmental gains. A recent study for EPA offered a "subjective, comparative assessment on where national environmental industry leaders stand."[20] Commenting on the relative standing of the major environmental infrastructure industry segments in which public authorities are important, this study suggested the following:

- Wastewater treatment companies in the United Kingdom and France are the world leaders.
- Among water utilities, U.S. companies lag far behind those based in the United Kingdom and France and are about even with Japanese companies. Companies from the United Kingdom and France are the largest and most efficient, with management, technology, and financial capabilities that surpass those of U.S. companies.
- U.S. solid waste management companies are the overall world leaders, but the remaining public authorities in this sector may not possess equivalent capabilities to private companies in the United States.
- German resource recovery companies have a slight edge over all other companies in the world, including U.S. companies.

A significant trend is reshaping the demand for industry products and services from stewardship organizations. This trend revolves around two competing public needs: restoration of contaminated public lands and return of these lands to productive use.

Federal, state, and local agencies that are stewards of public resources or regulatory organizations. A significant trend is reshaping the demand for industry products and services from stewardship organizations. This trend revolves around two competing public needs: restoration of contaminated public lands and return of these lands to productive use. Until recently, public insistence on complete cleanup (i.e., restoration of lands to pristine condition) was virtually absolute. In the past decade, however, a growing number of communities are asking regulators to balance the need to restore lands with the need for jobs, businesses, and use of the lands. A new term—"brownfields"—was coined to refer to lands that have been partially restored and upon which only limited uses are permitted. Permitted uses are matched to the contamination and risk that remains so that both productive use and safety are ensured. Thus, for

[20] Environmental Business International, Inc., Annual Survey, San Diego, CA, 1995.

example, use of brownfields for residences and schools is less likely than for industrial and other less sensitive purposes. Limited cleanup and containment of remaining contamination, plus monitoring of residual pollution at brownfields sites, have returned many properties to restricted use. This marketplace shift is simultaneously increasing the short-term expenditure on site remediation and reducing the long-term market. Efforts to privatize federal procurement of cleanup services and to use more performance-based procurement are discussed elsewhere in this study. No strong trends are otherwise apparent in the market in which federal, state, and local agencies manage public lands and buildings or procure products and services for regulatory purposes.

2.3 Government Regulations and Policies That Affect Development and Deployment of Environmental Solutions

Much of the world's economic progress over the past 100 years, particularly in the developed nations, has been made possible by technological advances aimed at using resources to better quality of life. The design and implementation of most technologies occurred, however, without considering impacts on the environment. As a result, environmental degradation often accompanied technology-based growth. The environment has been degraded worldwide, however, because of rapid population growth, urbanization, and industrialization.

More recently, a new family of technological advances has enabled some environmental gains and the more efficient use of resources. The game of technological "catch-up" for environmental improvement in the United States is impaired, however, by a number of barriers. These barriers discourage development and deployment of new technology-based products and services, many of which can strengthen the economy *and* benefit the environment. Taken together, the barriers comprise a formidable deterrent to technological investment, limiting innovation for both new productive technologies with sustainable designs *and* new environmental management technologies. The barriers arise from government policies—including financial, regulatory, and procurement—and business practices. In addition, inefficiencies in the investment of government research and development (R&D) resources and a lack of coordination between researchers in the government and the private sector reduce the rate of environmentally beneficial technology innovation. This section discusses many of the barriers that exist within the United States. International barriers are discussed later in this chapter.

The game of technological "catch-up" for environmental improvement in the United States is impaired, however, by a number of barriers.

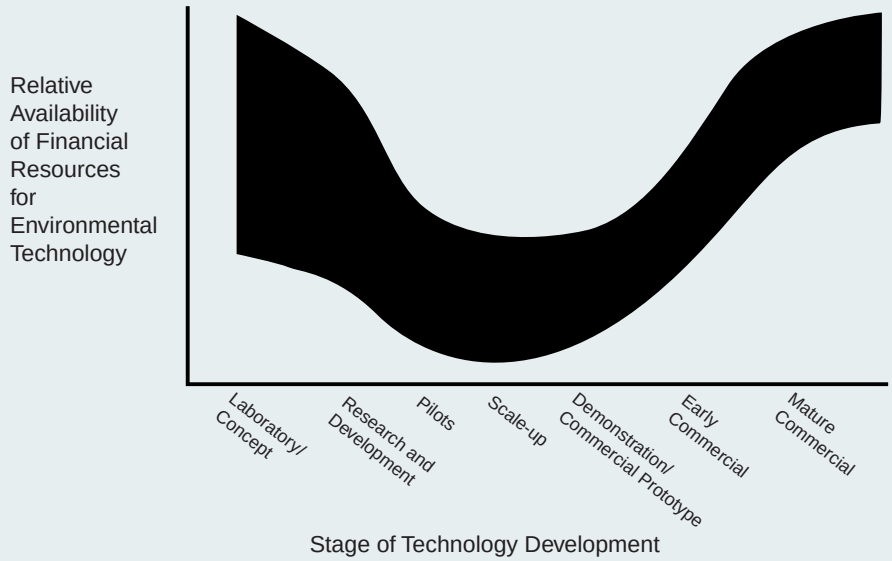
As environmental technologies mature, financing becomes increasingly difficult to obtain despite the fact that technical risks are declining and the technologies are progressing toward commercial development and market introduction.

2.3.1 The Effect of Barriers to Development and Use of New Technologies

A critical distortion exists in the availability of private-sector financial resources for environmental technology innovation and market development. This distortion is illustrated in Figure 3,[21] the "Valley of Death." The exhibit shows that as environmental technologies mature, financing becomes increasingly difficult to obtain despite the fact that technical risks are declining and the technologies are progressing toward commercial development and market introduction. Financial risks remain high despite technical progress because the value of a technology is dependent on its acceptance by environmental regulators. Customer acceptance is neither sufficient nor easy to get without regulatory acceptance.

Only after a technology-based environmental product or service is fully developed *and* is first approved by regulators for use for compliance purposes can financial risks be evaluated. At this point, investment decisions become more manageable. The special combination of technical and unique regulatory risks must be reduced for investment risk to be reduced. This is the case for two reasons. First, while regulations created the specific requirements that new technologies are designed to

Figure 3. The "Valley of Death"



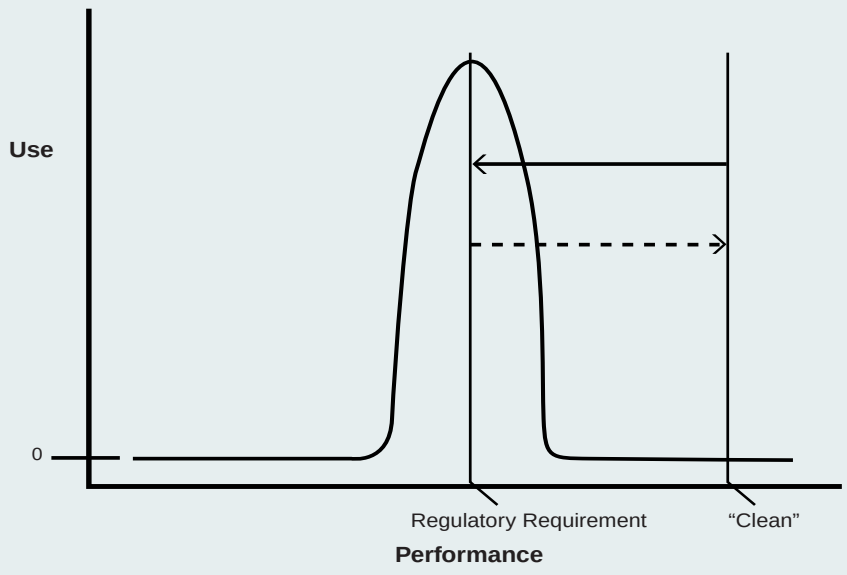
Source: Copyright David R. Berg

[21] Prepared by David R. Berg, ©Washington, DC, 1987. Reprinted with permission. The "Valley of Death" was originally known as the "Neck of the Hourglass," referring to the choke point in the flow of investment money that

meet, these technologies cannot be used without site-specific regulatory approval. Second, a number of unique attributes of environmental regulatory programs and the responses they produce diminish the ability of the private sector to develop products and services and to gain approval for their use. Because of the unique characteristics of the environmental management system, this problem is more severe than similar problems in other technology markets influenced by U.S. government regulations.

Figure 4[22] demonstrates that as U.S. environmental regulatory processes operate today, they are primarily strategies for ensuring the widespread use of *existing* environmental technologies, particularly those that can meet environmental requirements at the lowest cost of performance. Nearly all U.S. environmental regulations are based on the determination by regulators that an existing technology is capable of and cost-effective

Figure 4. Use of Technology for Environmental Improvement as a Function of Performance



Source: Copyright David R. Berg

As U.S. environmental regulatory processes operate today, they are primarily strategies for ensuring the widespread use of existing environmental technologies, particularly those that can meet environmental requirements at the lowest cost of performance.

supports technology innovation and technology-based business activity. This conceptualization was drawn and described in 1987 and first presented to a broad public audience at the initial meeting of EPA's National Advisory Council for Environmental Technology Transfer on September 22, 1988. Dag Syrrist, who was then with the venture capital firm Technology Funding, Inc., suggested the name the "Valley of Death" in 1990.

[22] Prepared by David R. Berg, ©1990. Reprinted with permission.

in improving environmental performance sufficiently for regulatory purposes. As seen in this exhibit, the performance capability of the technology must be sufficient to alleviate a specific environmental problem, but need not eliminate that problem completely. Technologies that perform inadequately for compliance purposes cannot be used because they will not be approved by regulators. Technologies capable of performing beyond regulatory requirements can be used for regulatory purposes, but may have disadvantages with respect to cost-effectiveness at the lower, required level of performance. In addition, new technologies must compete with established—or "locked-in"—technologies upon which the very standards were based. This competition is often one-sided because the new technologies must fulfill difficult and varying administrative process requirements for proving they can perform equivalently under the regulations, as well as overcome the ordinary difficulties new market entrants face. This combination of competitive disadvantages increases risk for new entrants in environmental markets and limits the attractiveness of these markets to investors. It also discourages creation of new technological tools that take users beyond current environmental requirements and that encourage a process of continuous environmental improvement.

In summary, most investors perceive the risks of environmental investment as especially difficult to measure, see the barriers to entry as particularly difficult to overcome, and believe that the environmental market is riskier than others.

In summary, most investors perceive the risks of environmental investment as especially difficult to measure, see the barriers to entry as particularly difficult to overcome, and believe that the environmental market is riskier than others. It is difficult for the financial community to *predict* the performance a technology under development will need to gain regulatory approval, and it is difficult to *gain* that approval. And for second and later entrants, it is difficult to *establish equivalency* and to *gain market share* against "locked-in" technologies upon which regulations were originally based. These are critical problems because the cost of bringing new technology-based products and services to the environmental market is far greater than the investment government agencies can make and is in fact far beyond the appropriate or acceptable role of government. The result is the so-called "Valley of Death," a deficit of investment capital that is particularly great for developmental environmental technologies. This deficit grows in severity during the period leading up to and including market entry.

2.3.2 Barriers to Product Innovation and Market Entry for New Technologies

The U.S. market for environmentally beneficial technologies is unique, but the environmental marketplace, in the words of one venture capital-

ist, "has a tendency to repel capital."[23] A broad spectrum of industry leaders and their customers has pointed out that many barriers constrain the development and commercialization of new environmentally beneficial technologies, including advanced industrial processes. The effect of these barriers can be seen in levels and patterns of investment in R&D by both the public and private sector, in product development and commercialization, and in purchases of environmental products and services. This section describes and explains the barriers, the combined effect of which is manifest in the "Valley of Death."

The U.S. market for environmentally beneficial technologies is unique, but the environmental marketplace, in the words of one venture capitalist, "has a tendency to repel capital."

Environmental regulatory processes and regulations have defined and expanded the demand for technology-based products and services related to the environment. Nevertheless, most critical barriers to environmentally beneficial technology innovation and diffusion arise *within* the U.S. environmental management system.[24] These barriers are the following:

- ***Regulatory barriers that slow technology R&D and inhibit product introduction.*** Regulations are the primary determinant of the performance required of environmental technologies, the sources to which they must be applied, the timing of their use, and the longevity of their application. Yet, as noted succinctly by the Office of Technology Assessment, "There is little emphasis on

[23] Frank Pope, about 1992. Mr. Pope was then a principal in the venture capital firm, Technology Funding, Inc., San Mateo, CA.

[24] The earliest documentation of this subject is in the 1990, 1991, 1992, and 1993 reports of the Technology Innovation and Economics Committee (TIE), a standing committee of the National Advisory Council for Environmental Policy and Technology, the administrator of EPA's external policy advisory group. These reports are: (1) *Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation* (#EPA 101/N-91-001; January 1991), (2) *Improving Technology Diffusion for Environmental Protection*, *op. cit.*, and (3) *Transforming Environmental Permitting and Compliance Policies to Promote Pollution Prevention: Removing Barriers and Providing Incentives to Foster Technology Innovation, Economic Productivity, and Environmental Protection* (#EPA 100-R-93-004; April 1993). Similar points were raised for the chemical industry, particularly with respect to worker safety, in a paper by Nicholas Ashford and George Heaton, "Regulation and Technological Innovation in the Chemical Industry," *Journal of Law and Contemporary Problems*, 1983, page 46, and more generally in Nicholas Ashford, C. Ayers, and R. Stone, "Using Regulations to Change the Market for Innovation," *Harvard Environmental Law Review, 9*, 1985. Several later studies address barriers to development and use of innovative environmentally beneficial technologies. They include (1) U.S. Congress, Office of Technology Assessment, *Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities*, Washington,

Regulatory inattention and disincentives to development and use of new technologies increase risks for technology developers, the investment community, customers of the environmental industry, and the public.

technology development and innovation."[25] Regulatory inattention and disincentives to development and use of new technologies increase risks for technology developers, the investment community, customers of the environmental industry, and the public.

- ***Regulatory policies that fail to reward deployment of new advantageous technologies.*** These policies increase the time to market and cost of new environmental technologies. They also make it more difficult for small companies to successfully bring new technologies from the laboratory to the marketplace.

- ***Inefficiencies in the information system used by policymakers, the environmental industry, and customers of the industry to speed widespread use of new technologies.*** These inefficiencies restrict the flow of investment capital to environmental companies.

Important barriers to environmentally beneficial technology change also exist *outside* the environmental management system in the United States. Perhaps foremost of these is the pricing structure of energy and other raw materials in the United States. Their pricing is based more on short-term market factors than on long-term resource considerations and full-cost pricing. The relatively low and stable price of petroleum, for example, has reduced demand for technologies that consume less energy and has reduced market share for other sources of energy. Another barrier can be fiscal policies that may affect private R&D investment decisions. These barriers have had several important negative effects on the originators of environmentally beneficial technologies.

In sum, these barriers have shaped most sectors of the environmental industry *and* sources of environmentally beneficial technologies outside the industry in a number of ways. These include reduced investment in R&D, a reduced rate of technology innovation, and a low rate of investment in companies active in environment-related innovation.

DC, January 1994, particularly Chapter 9; (2) National Environmental Technology Applications Center (NETAC), *Barriers to Environmental Technology Commercialization*, Pittsburgh, PA, April 1995; (3) Heaton and Banks, "Toward a New Generation of Environmental Technology: The Need for Legislative Reform," *Journal of Industrial Ecology*, volume 1, number 2, 1997; (4) Dan Esty and Marian Chertow, editors, *Thinking Ecologically: The Next Generation of Environmental Policy*, Yale University Press, New Haven, CT, 1997; and (5) Environmental Law Institute (ELI), *op. cit.*

[25] Office of Technology Assessment, *op. cit.*, page 263.

Regulatory Barriers to Technology Innovation and Diffusion

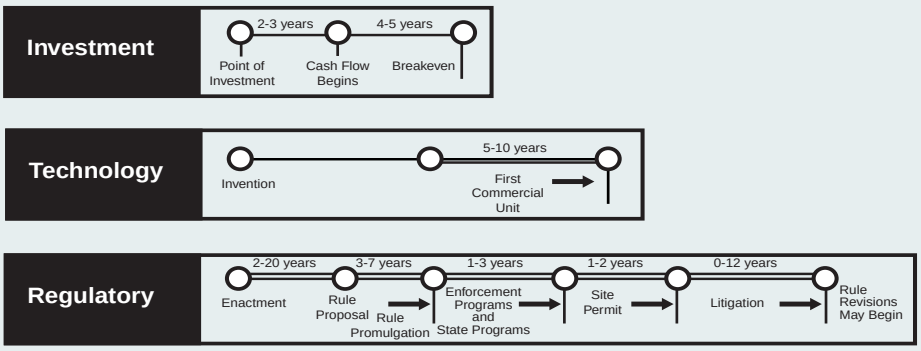
Twenty-five years of government programs for environmental management dominated by the "command and control" system created and shaped the environmental market. A number of peculiarities and externalities associated with these programs have made them uniquely restrictive of technology innovation and commercialization. These are the primary points of differentiation between the environmental market and other markets, even markets with large regulatory roles for government. Some of these restrictions diminish the ability of the private sector to develop and use new environmentally beneficial technologies.

Figure 5 [26] describes the core of this analysis of environmentally relevant innovation in the United States. This exhibit illustrates a fundamental incompatibility among three crucial time lines: investment, technology and product development, and regulatory promulgation and implementation. This incompatibility explains how regulatory programs slow and constrain domestic development and use of new environmental technologies, creating conditions reflected in the "Valley of Death."

As shown in the first of three time lines in this exhibit, an expectation exists that higher risk investments, such as those in young companies and those for new technology-based products, will mature in 3 to 5 years.

Regulatory programs slow and constrain domestic development and use of new environmental technologies, creating conditions reflected in the "Valley of Death."

Figure 5. Incompatibility of Investment, Technology, and Regulatory Time Lines



Source: Copyright David R. Berg

[26] Prepared by David R. Berg, ©Washington, DC, 1987. Reprinted with permission. The incompatible time lines conceptualization was drawn and described in 1987 and first presented to a broad public audience at the initial meeting of the National Advisory Council for Environmental Technology Transfer on September 22, 1988.

This is shorter than the 5 to 10 years required from the point of invention to develop and introduce to the market technology-based products, as seen in the second time line. Thus in the United States, investments in new technology tend to occur late in the development cycle. (To avoid this problem, many environmental technology developers self-finance their efforts, especially in the early stages of development, or rely on government support or investor "angels." Particularly among larger environmental companies, this pattern of self-financing R&D has been aided by the R&D tax credit policy.) In countries that are the major trading partners of the United States, countries where the discount rate has tended to be lower, the investment and technology time lines have been better matched over the past 25 years.

There is no "window of opportunity" for technology development and commercialization in this regulatory cycle.

The U.S. investment problem is compounded in the environmental market because of the unique characteristics of environmental regulations. As seen in the third time line, the large majority of environmental requirements become increasingly precise over a rather long period of time. Moreover, there is no "window of opportunity" for technology development and commercialization in this regulatory cycle. From the start of development of a regulation, the process proceeds in short steps with increasing specificity until regulations are proposed and promulgated, state programs are established, the new rules are applied to individual facilities, and near-term compliance deadlines are set. It is only at the end of the process that the specific requirements for a site become fully known and the applicability of individual technologies to that site can be determined. By then, inadequate time exists for innovation. In other cases in which regulatory limits are universal, rather than site specific, the process is somewhat shorter but equally inadequate for innovation to occur. This inability to predict general or site-specific regulatory performance requirements far in advance particularly discourages innovation.

Regulations have, in fact, usually been based on technologies available when the regulations were written, and each new regulation "locks in" this "best" technological alternative. The term "best available technology" (BAT), and its analogues (e.g., BDAT, MACT, LAER), underlie nearly all regulations that apply to stationary sources of air pollution, to sources of waste water, and to treatment requirements for hazardous waste. These terms are written into most of the major environmental laws.

Only a limited number of regulations have been generated by the EPA that depart from this model. Most have involved outright bans of specific

substances, which made innovation inevitable. These include the mandated phaseout of ozone-depleting chlorinated fluorocarbons (CFCs), the ban of persistent pesticides, the ban of polychlorinated biphenyls (PCBs), the ban of dispersive uses of lead, the cap on acid rain precursors, and emission limits for automobiles. These examples share important characteristics: predictable markets and measurable targets.

Moreover, since compliance is the desired or required regulatory outcome, no incentives exist to exceed required performance. This, too, differentiates the environmental market from other markets (e.g., pharmaceuticals). Thus, as illustrated in Figure 3, most environmental regulations are primarily strategies for ensuring the widespread use of existing environmental technologies. Technologies whose performance meets regulatory requirements reliably and at the lowest cost of performance usually gain the largest market share, and the original technology upon which the standard was based is usually locked in to the market leadership position. Technologies that perform efficiently at regulatory levels but are developed later must compete with the locked in technology upon which the regulation was based. New entrants not only must compete in the market with this entrenched technology, they must also demonstrate to regulators, at the developer's expense, equivalent performance in each jurisdiction and on a case-by-case basis when use is proposed. These barriers place new technologies at a competitive disadvantage. And with satisfactory performance defined in regulations, few incentives exist for postregulatory innovation or for continuous environmental improvement using higher performing technologies, even if environmental objectives are not being met regionally. (For example, despite substantial compliance with requirements for reductions by nearly all major air pollution sources and many smaller sources, a majority of the largest U.S. cities experience levels of the "criteria" air pollutants [e.g., ozone, nitrogen oxides, carbon monoxide] that exceed standards a significant number of days each year. Similarly, despite substantial regulatory compliance by most dischargers, 40% of U.S. rivers remain unsafe to swim in, and fish in them remain unsafe to eat.[27])

Since compliance is the desired or required regulatory outcome, no incentives exist to exceed required performance.

Several distinct types of regulatory barriers are central to the low rate of technology innovation and diffusion in most sectors of the environmental market. Although they have been well documented,[28] few have been alleviated in a fundamental way:

[27] Environmental Protection Agency, 1998.

[28] Technology Innovation and Economics Committee, *op. cit.*, Office of Technology Assessment, *op. cit.*, National Environmental Technology Applications Center, *op. cit.*, Heaton and Banks, *op. cit.;* Esty and Chertow, *op. cit.*

Single-media, source-specific regulations force environmental decisionmakers to focus on the trees rather than the forest.

- ***Single-media and source-specific regulations and regulatory processes.*** Single-media, source-specific regulations force environmental decisionmakers to focus on the trees rather than the forest. Each requirement covering each category of environmental release must be met in an independent process and on its own schedule. Each requirement is based on the performance of a technology that was commercially available at the time EPA developed the rule and promulgated it. This type of regulatory strategy creates disincentives for integrated economic and environmental decisionmaking, creates disincentives for innovation, and pushes managers to select end-of-pipe solutions to each separate environmental problem.[29]

- ***Overly prescriptive, inflexible, and unpredictable regulations and regulatory processes.*** Compliance with BAT-based regulations requires the quick use of a technology with the requisite performance and provides no reward for the development and use of a technology offering improved performance, regardless of the environmental and public health risk remaining after use of BAT. Since EPA bases its rules on the availability of a technology and states its goal only when a rule is proposed, it is far too late to begin R&D aimed at finding an innovative solution when EPA proposes a rule. Environmental goals are uncertain until regulations are promulgated *and* permits are written for a specific source. The timing of the conclusion of this process is not known until it is too late for innovation, and revision of regulations and site-specific requirements does not happen until it happens. Thus, industry leaders believe that uncertainty about the timing, goals, and longevity of regulations increases investment risk and discourages development and use of innovative technology for environmental purposes.[30]

- ***The difficulty of establishing that new technologies provide equivalent performance to accepted technologies.*** Most EPA rules are written as performance-based regulations, but based on a pre-existing technology. Other technological solutions can be used site by site, although only after permit officials and other stake-

[29] Technology Innovation and Economics Committee, *op. cit.*; Office of Technology Assessment, *op. cit.*, pages 267ff.

[30] Technology Innovation and Economics Committee, *op. cit.*, particularly *Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation, op. cit.* See also Office of Technology Assessment, *ibid.*, e.g., page 264 ("Principal Findings").

holders agree. Establishing that an alternative technology performs reliably as required is a time-consuming, expensive process, and the burden of proof rests squarely with the company that proposes to use the alternative solution. The extra costs and the uncertainties associated with this process, as well as the lack of time available to develop and apply a technology, make development and use of alternative technologies generally unattractive, say industry leaders.

- ***Permitting rules and practices that make technology development and testing difficult during the R&D cycle, especially after tests at the laboratory bench.*** An EPA advisory committee wrote in 1991, "There is no functional permitting system for testing and demonstrating innovative environmental technology."[31] Industry leaders and their customers note that testing is sometimes easier in the United States today, but that many new environmental and production technologies are tried and used first overseas, in part to avoid regulatory delays in the United States.

- ***Permitting rules and practices that make it difficult to gain approval for use of new technology-based products.*** A lack of institutional recognition for the high priority of technology innovation and the complexity of the permit application process inhibit many technological ideas from flourishing, cause excessive time delay, and impose excessive costs on development and early commercial uses of innovative technologies.[32] As Amoco noted to the Office of Technology Assessment in 1993, "If firms choose a different type of technology, they can have difficulty getting approval, since permit writers often do not have the time or the inclination to approve approaches different from those normally prescribed."[33] Industry leaders say this is still the case in most states today.

- ***Compliance and enforcement practices that are sometimes weak, unpredictable, and inconsistent.*** As noted earlier, two periods of weakness in the market in the early 1980s and most of the 1990s seem related to the diminishment of enforcement. Industry lead-

A lack of institutional recognition for the high priority of technology innovation and the complexity of the permit application process inhibit many technological ideas from flourishing, cause excessive time delay, and impose excessive costs on development and early commercial uses of innovative technologies.

[31] Technology Innovation and Economics Committee, *Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation, op. cit.*, page 29.

[32] Technology Innovation and Economics Committee, *Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation, op. cit.*, page 30.

[33] Office of Technology Assessment, *op. cit.*, page 272.

A lack of predictable and consistent enforcement at all levels of government dampens companies' belief that they need to comply with environmental requirements.

ers say that constancy in enforcement is fundamental to their market. A lack of predictable and consistent enforcement at all levels of government dampens companies' belief that they need to comply with environmental requirements. This diminishes or forestalls the need to purchase environmental products and services and discourages use of innovative technologies, factors that inherently increase technology developers' exposure to risk. So, entrepreneurs are discouraged from investing money and effort in bringing new technologies to market.

- ***Regulations and regulatory processes, including compliance and enforcement procedures, that differ across and even within state borders.*** Starting in the 1980s, administration of air, water, solid waste, and hazardous waste regulations was increasingly delegated to the states. The result was that the U.S. market was divided into more than 50 large pieces and a number of smaller ones, each administered by an independent authority (state or regional) for each of the environmental media. Today, the administrative processes through which requirements are applied differ across the states, and no national-level system exists to oversee development and commercial introduction of new technological solutions. This means that a technology must often be introduced separately in each state and retested state by state, and data and documentation required for regulatory acceptance (as evidenced through the issuance of permits, compliance agreements, and certifications) must be developed in a manner that conforms to the processes and procedures of each state. Fragmentation increases the cost of using new technologies.

Industry leaders suggest that a more efficient practice to promote technology innovation and diffusion would be to base environmental requirements on performance measured over time (e.g., units of a type of emissions/residuals, or facilitywide, in all media per unit of output; allowable aggregate risk), allowing companies to choose how they will meet these requirements and deadlines, subject to auditing or other assurance mechanisms. This practice would bring to bear market forces in which companies renew their environmental technology choices as they continually seek to reduce operating costs and improve products, as well as gain other competitive advantages. In such a system, companies would gain incentives to integrate environmental decisions with other production decisions, and both the economy and the environment could benefit.

Regulatory Penalties for Failure to Comply

Companies that fail to achieve compliance with environmental regulations are subject to penalties issued by regulators, often enforced by the courts. Even if a company made a bona fide effort to comply using an innovative, but unproven, technology that failed, no "soft landing" (amelioration of the penalty) is available. After such a failure, companies must reach compliance quickly, and it is unusual for regulators to allow special consideration for the failed attempt. This is the case even if the failure is by a small margin. Thus, technologies that fail cost companies three—and sometimes four—ways: first, to install the technology that failed; second, to pay the compliance penalties; third, to replace the technology with a conventional one; and fourth, for downtime in the operation that was out of compliance.

Risks of Liability to Other Parties

Liability to parties other than regulators has emerged as another major deterrent to environmentally beneficial innovation. Two types of liability are among the most important; each multiplies the potential risk to the providers of technology-based products and services *and* to their customers:

- ***Tort liability.*** Companies providing technology-based products and services that fail to meet regulatory standards are not only exposed to claims for nonperformance of the technology, but also for the loss of revenues from production interrupted by the failure. Companies that use innovative solutions may also be found liable for damages associated with the failure and suffered by workers or nearby communities.

- ***Joint and several liability under the Superfund law.*** The Superfund law provides, in general, that *any* party having a connection with an abandoned waste site listed under Superfund can be assessed with the *total* cost of remediating the site, plus any damages caused by the pollution at the site. This provision applies to the companies that perform work during the cleanup or provide products used in the cleanup, as well as to the companies that caused the pollution problems at the site.

Nonregulatory Barriers to Technology Innovation and Diffusion

Several nonregulatory barriers are also significant factors in the development and use of new products and services based on environmentally

beneficial technologies. Some of these major nonregulatory barriers are the following:

- ***Patent policies and practices in the United States and abroad.*** Two distinct issues exist regarding patent protection. First, while patent protection is well developed in the United States and other industrialized nations, environmental executives report that they have experienced some problems in protecting their inventions in other less developed countries. Second, industry leaders would like to see agencies performing environmental research reaffirm their commitment to the patenting and licensing to the private sector of inventions originating in government laboratories.

- ***Information barriers.*** As noted by the World Resources Institute's Banks and Heaton,[34] "Environmental improvement presents highly technical issues... Often, the firms are willing to change but need technical assistance to do so." Similarly, improved technologies present challenges to regulatory officials who are often willing to permit the use, but do not approve it because they lack confidence in the technology's capability or reliability. Entrepreneurial firms would take licenses to develop commercial products based on new technologies, if only they knew that licensing opportunities were available. These and other barriers arising from the imperfect distribution of information impair the flow of new technology ideas from the laboratory to the marketplace.

Barriers arising from the imperfect distribution of information impair the flow of new technology ideas from the laboratory to the marketplace.

- ***Deployment barriers in federal procurement.*** Many barriers to the deployment of innovative solutions exist within federal procurement policies and practices, and a number of these are widely recognized. For example, the Department of Defense's MILSPECs (military specifications) have been widely recognized as retarding the introduction of new technologies. The Department of Energy's (DOE's) Environmental Management Advisory Board (EMAB) has described a number of departmental and other practices that operate as primary barriers to the deployment of innovative solutions for DOE environmental management. EMAB stated that these barriers include

[34] R. Darryl Banks and George R. Heaton, Jr., "An Innovation-Driven Environmental Policy," *Issues in Science and Technology*, fall 1995, pages 46–47.

- "a cumbersome procurement process that encourages the status quo;
- an inadequate linkage between the technology development program and the technology deployment program, including a lack of adequate site characterizations and insufficient technology performance or cost data;
- the potential liability exposure for technology developers;
- the lack of performance-based criteria that encourage innovation;
- a multilevel permitting process that is inconsistent from state to state; and
- the Not Invented Here mindset within DOE that discourages all but the most hardy technology developers."[35]

Inadequacies in R&D for Environmentally Beneficial Technologies

Low rates of private and public investment in environmental technology R&D, a lack of coordination between researchers in the government and private sectors, and inefficiencies in the investment of government R&D resources reduce the rate of environmentally beneficial technology innovation, say industry leaders. Environmental companies' investment rate in R&D for new products and services is very low compared with other industries, and R&D investment is concentrated in about half of the industry's segments. Many U.S. engineering, environmental infrastructure, and service companies make no investments in technology R&D and product development. The number of companies on the equipment side investing in research continues to decline because of market uncertainties, and companies in even these segments invest only about 3% of their revenues in research, most of it for short-

Environmental companies' investment rate in R&D for new products and services is very low compared with other industries, and R&D investment is concentrated in about half of the industry's segments.

[35] Letter from the Environmental Management Advisory Board (EMAB) to the U.S. Department of Energy, April 25, 1996. The findings of EMAB's Technology Development and Transfer Committee regarding barriers to environmental technology commercialization were adopted by the full EMAB on September 14, 1995. These documents and other EMAB recommendations may be found at www.em.doe.gov/stake/envir.html.

term product development projects.[36] By contrast, companies in such high growth rate industries as semiconductors invest about 10% of revenues in R&D.

New environmentally beneficial technology ideas originate from R&D funded by both government and nongovernment organizations, some from outside R&D categories traditionally considered environmental (e.g., industrial process R&D, energy efficiency R&D). The private sector sponsors 80% to 90% of known R&D investment for environmentally beneficial technologies. Overall, government supports about 20% when R&D for other types of environmentally beneficial technology are included. Government supports a higher proportion of the total U.S. investment for basic research and earlier applied R&D than does the private sector, and a lower proportion of the total support for later stage R&D and for product development. The government share of this R&D investment also varies widely depending on the type of technology considered. Government's investment reaches a 50% share in a few of these R&D areas, such as environmental remediation and space-based sensors—areas in which the government is a major customer. Government also sponsors a large portion of energy R&D, much of which has a strong environmental component (e.g., fossil energy, energy efficiency, and new energy sources). Banks and Heaton argue that not only are *more* government technology R&D dollars needed for the environment, but that a greater portion should be directed at opportunities to "trigger improvements in industrial technology" and to "environmental technology development."

Coordination of public- and private-sector research is particularly important in the environmental area because public policy objectives with respect to the environment must largely be reached through the use of improved technologies in the private sector's products and processes. Moreover, the government's investment in new technologies will be largely futile unless those technologies are further developed into products and used by the nation's industries. Overall, industry leaders suggest, perhaps the two greatest inadequacies in current government programs that fund the development of government technologies are (1) lack of government facilitation for private sector technology development efforts and (2) lack of coordination and collaboration between government researchers and the private sector. Simply put, these inadequacies waste large amounts of R&D dollars in both sectors and product development dollars in the private sector. Two discussions of the

[36] Environmental Law Institute, *Research and Development Practices in the Environmental Technology Industry*, Washington, DC, September 1997.

need for an enhanced relationship and how to achieve it are presented in the EPA advisory committee report, *Improving Technology Diffusion for Environmental Protection*[37] and in Heaton and Banks, *Toward a New Generation of Environmental Technology*.[38]

Industry leaders identify two important shifts in the allocation of government R&D funds. First, they believe that federal, state, and local governments must increase their commitment to facilitating the commercialization of new environmental technologies. Parts of EPA's *Technology Innovation Strategy*,[39] issued as a draft in January 1994, directly address this need for a *functional* redistribution of government technology R&D activities. The strategy identifies the need to "strengthen the capacity of technology developers and users to succeed in environmental technology innovation" or, in other words, to "catalyze the technology development and commercialization efforts of other organizations." These facilitation activities would help the private sector gain information, skills, tools, and facilities required to move technology-based products and services into marketplace competition. For example, a federally supported system that verifies the performance of new technologies could ease market entry by facilitating permit decisions that precede use. Several important regulatory changes discussed in Chapter 3 would complement this resource shift.

Second, a related inadequacy in most government environmental R&D programs, industry leaders note, is the failure to consider the potential for commercialization in selecting research programs to be supported. Too often, the marketplace potential of technologies (i.e., market and business factors) is ignored, while technical merit and programmatic relevance dominate. Consideration of commercialization potential is one important way to increase adoption of new environmental technologies by the private sector, and only through such commercial use of new technologies can national environmental goals be reached. The prospects for private-sector adoption of government-funded technologies may also be improved by transfer of the results of government research to the private sector for further development and commercialization. Law and policy now favor

[37] The TIE Committee, *Improving Technology Diffusion for Environmental Protection, op. cit.*, pages ix, 73ff, and 97ff. Coordination and collaboration is especially discussed on pages 97ff, partnership and leveraging is discussed on pages 103ff, and the need to focus on the commercial end point is discussed on pages 199ff. See also Banks and Heaton, *ibid*.; Office of Technology Assessment, *op. cit.;* and Heaton and Banks, *op. cit.*

[38] *Ibid.*

[39] U.S. Environmental Protection Agency, *EPA Technology Innovation Strategy (external discussion draft)*, January 1994. Note that this strategy has never been finalized.

such transfers (e.g., the Federal Technology Transfer Act, the Bayh-Dole Act), and the relative tightness of public environmental R&D budgets has increased the need for cooperation with private-sector R&D organizations under these laws.

2.4 Emergence of a Worldwide Market

The rapid growth in overseas environmental markets has changed the U.S. environmental industry forever. The profound effects of exponential population growth, technological change, and urbanization are fueling these markets by placing enormous pressures on natural resources and the environment. Fortunately, rapid economic growth, especially in parts of Asia and Latin America, is generating the means to remedy critical environmental degradation across these regions. To the degree that the will to take protective action exists, these markets will continue to grow rapidly. In other regions, population growth is swallowing up both the capacity and the will to pay for environmental protection. Regardless, the global market surpassed the U.S. environmental market earlier this decade, and will far outdistance the U.S. market in size if current trends continue. With increased competition and declining profits in the U.S. home market, more companies expect foreign markets to offer significant future opportunities.

The global market surpassed the U.S. environmental market earlier this decade, and will far outdistance the U.S. market in size if current trends continue.

The $453 billion global environmental market is growing faster than the global economy and at a pace that outstrips growth in the U.S. environmental market, as seen in Table 8. The global market is made up of two distinct parts: industrial markets, in which demand may be as sophisticated as in the United States, and developing markets, in which demand is dominated by the need for environmental infrastructure (e.g., potable water, wastewater treatment, and solid waste disposal).

In developed countries and those developing countries with high-technology industries, demand exists for advanced environmental products and services. If multinational companies' facilities are the source of this demand, their environmental objectives may equal those required in the United States despite the lack of equally stringent requirements in the host country. In addition, these customers often seek multimedia environmental solutions, challenging environmental companies to expand their range of products or services. Moreover, foreign regulators are more likely to use economic instruments than are U.S. regulators (e.g., pollution taxes, discharge fees, negotiation, and land use changes to encourage more sustainable behavior). Experimentation with flexible regulatory processes is quite widespread in foreign countries, as is experimentation with mar-

ket forces, and economic value is sometimes given greater weight in the choice of environmental solutions in those countries. For example, Poland uses air pollution taxes, China uses wastewater discharge fees, Holland and Korea use packaging deposit/refund systems, Indonesia and Brazil use watershed charges, Malaysia and Guatemala use carbon offsets, Thailand uses tradable noncompliance permits, and China and Germany use overcompliance credits.

The most rapid market growth is occurring in the developing nations, where booming populations, high-paced urbanization, and technological advances place tremendous burdens on the environment and create demand for improved infrastructure. In many of these countries, an environmental crisis of incomparable proportions threatens both current and future generations. The mass loading of regional environmental systems from untreated sewage and industrial discharges, as well as from heavy deforestation, is occurring there on an unprecedented scale. The crisis of environmental degradation is most evident in the developing world (e.g., the rivers and skies near the enormous cities of eastern Asia) and in former Soviet bloc countries. Demand in many of these countries is limited more by a lack of commitment to remediate environmental crises and an inability to pay than by an absence of regulations requiring environmental protection.

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Large-scale infrastructure projects are in evidence around the globe, many of them financed by the multilateral development banks and equity markets through the granting of concessions (i.e., official development rights awarded by governments to private parties). Energy, transportation, communications, and environment infrastructure development comprise a fourfold platform that can lift people in developing countries to a level that allows them to participate in today's global economic transformation. The environmental component of the fourfold system is, perhaps, the most important for improving the quality of life for large segments of the population. When people are sickened from dirty drinking water and polluted air, and their food is contaminated with dangerous chemicals, faster transport, better communications, and modern energy supplies are hardly relevant to their well-being. Basic environmental protections are the greatest challenge to infrastructure development in the developing world because they present complex, interactive problems that need to be integrated on several different levels. These include, but are not limited to, economic (and financial), sociological (and cultural), and physical (resource availability, delivery of product to households, and traditional land use patterns).

While forecasts for environmental market growth in developed nations range from 2% to 5% over the next few years, growth in the rest of the world will average over 10%. This compelling fact is emerging despite the many difficulties associated with conducting business in foreign markets. In many cases, business development assets invested in international markets will have a higher return than those invested in domestic markets.

The case for export initiatives by U.S. companies is not always clear, however, because *achieving* these returns is not straightforward, and investment returns will not often be achieved in short order. It is clear that market maturity is an unavoidable fact in most domestic market segments. Another point is clear: U.S. companies face stiff competition in key established international markets, as well as in the domestic market. The nations of Japan, Germany, Great Britain, Canada, France, Korea, the Netherlands, and Scandinavia, just to name a few, have coordinated environmental and export strategies aiming to win the battle for global market share. Their tactics include export support (e.g., "tied aid"), business training, favorable financing packages, and technology and knowledge transfer. They combine these tactics with domestic market development and technology-friendly policies at home (including research and development support) to hone the competitiveness of their environmental industries.

The U.S. environmental industry has noticeably improved its performance in international markets in the past few years, though there is still room for improvement.

The U.S. environmental industry has noticeably improved its performance in international markets in the past few years, though there is still room for improvement, as discussed in Chapter 1. Led by exports of recycled metals, environmental exports increased from $9.6 billion in 1993, to $11.5 billion in 1994, to $14.7 billion in 1995, and to $16 billion in 1996, producing a trade surplus of $9.3 billion for that year. Despite this 64% growth in 3 years, the U.S. environmental industry still generates only 9% of its revenues from outside its borders (compared with 15% to 20% for our major competitors in Japan, Germany, and other countries in Western Europe), and U.S. environmental companies have gained only 6% of non-U.S. markets. In addition, imports into the U.S. market are also growing, necessitating continued industry investment to preserve and expand competitiveness, and foreign competitors have acquired a number of significant U.S. environmental firms.

The remaining question is where are these international markets and what products and services do they demand? Globally, market needs outpace the capacity to provide environmental solutions, so U.S. companies have significant opportunities. The quick answer is Asia, Latin

America, and perhaps parts of Western and Central Europe. The best opportunities in developing nations are for segments related to water, wastewater, and to a lesser extent waste and air quality. In markets that are similar to the United States, the best opportunities are for such segments as instrumentation, pollution prevention, and efficient industrial processes. But there really is no quick answer. Many U.S. companies, especially larger ones, have taken steps to participate, and more companies can and will in the future, providing a wider and wider range of products and services needed by potential customers worldwide. Most small and medium-sized firms will continue to have difficulties extending their businesses internationally because they lack the necessary financial resources and the integrated products and services to compete. Each company and each major product or service line must set priorities among market opportunities and plan strategically for international business.

While participation in global environmental markets can be worthwhile, the amount of investment required is certainly larger than in the domestic market—and its payback period is usually considerably longer. The international environmental market is not feasible territory for most small firms or the faint of heart. Success demands foresight, dedication, commitment, and patience. For some companies, exports will be an important source of growth, but for most they will not. In any event, it is important to note that success in thriving pockets of growth in international markets will *not* make up for the lack of growth in U.S. markets.

2.5 Finance: The Role of the Capital Markets in the Environmental Marketplace

While capital is abundant in the U.S. economy, little of it is directed toward the environmental industry. In 1996, for example, less than 1% of all venture capital was directed into environmental technologies and start-up companies. The National Science and Technology Council (NSTC) reported[40] that in 1993 approximately $31 million in venture capital was invested in just 12 firms developing new pollution control and remediation technology products. NSTC reported that in 1994, only $25 million was invested in fewer than 10 companies. A more inclusive assessment of venture investment in the environmental industry by Environmental Business International, Inc., indicates that these venture capital investments peaked at $200 million in 1990 following fairly rapid

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[40] National Science and Technology Council, *op. cit.*, page 44.

Overall the industry's capital structure is quite weak.

growth and then declined steadily to only $30 million in 1996.[41] Monies raised from initial public offerings for environmental companies have shown similar trends, peaking at an average of 20 companies per year from 1987 to 1991 and sinking to 2 or 3 per year since 1995. The environmental industry has attracted very little investment money in recent years to finance new companies from all sources. Capital markets are tight, as well, for companies that develop new environmental products and services, including those that are technology based. In fact, *overall* the industry's capital structure is quite weak.

The reasons for the scarcity of capital are clear. As discussed earlier, barriers to profitable operations are large, and environmental companies struggle for capital at all points along the supply curve. This struggle raises their average cost of capital and further diminishes their profitability and competitiveness.

2.5.1 Declining Interest by All Capital Sectors

For this industry to grow and mature, capital must be available for both the demand and supply sides of the economic equation: to companies that need to use environmental products and services (the demand side) and to companies that develop and sell environmental products and services (the supply side).

On the demand side of the market, most companies see environmental actions as a cost center only. The parties with ultimate responsibility for results must walk a fine line—trying to achieve a balance weighting actions which improve environmental performance against revenue-generating business activities. Not enough and they fail to comply with regulations; too much environmental investment makes it hard to compete. Companies have tended to blame the financial markets for forcing them to focus on short-term results, and the government for imposing large environmental costs. They cite the facts that financial rewards for companies taking a longer view are few and regulators are highly process oriented. As a result, many companies apply different internal "hurdle" rates (which set a threshold for return on investment for company investments) for environmental and other investments. Many use higher hurdle rates for environmental investments other than those needed for immediate compliance.

Access to capital is important at different points and for differing purposes during the life cycle of environment-related businesses and their

[41] Environmental Law Institute., *op. cit.*

customers. At present, most of the distinct sources of capital have reduced their commitments to the industry. These specific sources are the following:

- ***Angels.*** Wealthy individuals who take an interest in a new technology or know an entrepreneur personally are an important source of early capital for start-up companies. Angels are a vital, though unorganized, slice of the capital markets. They are particularly important for the formation of new, small companies. Unfortunately, angels are not a well-organized source of capital, and they have not been available to many environmental start-up companies.

- ***Venture capital.*** This is the type of capital most used for the commercialization of new products and services. This capital is needed to get a company from the start-up phase—supported by angel capital—through the growth phase until a company reaches an efficient size to go public. By this point, a company's technology will be incorporated into real products, and operating revenues will be significant. The supply of venture capital to the environmental sector has declined by more than 90% over the past several years because the barriers to making a profit are too large and the risks of investment are too hard to manage.

- ***Commercial bank lenders.*** Typically, commercial lenders provide the loans, letters of credit, trade financing, money transfers, and other money vehicles that fuel business operations for environmental companies and their customers. Most banks now conduct some environmental risk analysis when they consider important transactions. Size is relevant: Small companies are harder to deal with. Commercial lending has usually been available for environmental businesses, although less so for companies involved in site remediation because of the risk of joint and several liability under Superfund. This lending is also becoming less available to industry segments that are contracting and that have low rates of profitability (e.g., hazardous waste management). Lenders are becoming increasingly aware that the creditworthiness of the industry's customers depends on environmental performance and residual liabilities, and that both of these measures are affected by resource productivity. Because of the potential for loss of capital, banks are less likely to make loans without examining their exposure to liability, risk of losing capital, the present value of companies' costs in future cleanup actions, exposure to civil

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damages and personal injury suits, and the value of collateral if they must foreclose.

- ***Investment banks.*** As facilitators of the transfer of capital from holders of money to users of money, investment banks participate in transaction-oriented deals, such as the issuance of common stock, other equity placements, mergers and acquisitions, and business brokerage. They often raise capital for companies in the public/listed markets where securities are then traded actively. "Private placement" to institutional investors of equity or debt-equity combinations is also a large part of their business. Unlike angels and venture capital sources, they largely react to market forces rather than shape demand. They employ, however, most of the equity analysts who are important to environmental companies' ability to raise growth capital. Very few investment banks focus on the environmental industry because the fees they generate from deals in this sector are low and because investment returns have often been low compared with nonenvironmental opportunities.

Companies will invest their own money in environmental R&D if they need a new technology themselves or if they see a market opportunity.

- ***Capital from operations (cash flow).*** Most of the technology R&D that leads to new environmental products and services in the United States is supported by companies' own capital, the source of which is operations for most companies plus start-up capital for newer companies. Companies will invest their own money in environmental R&D if they need a new technology themselves or if they see a market opportunity. Most environmental technology R&D by U.S. companies is designed to develop technologies needed for internal use only, and as noted earlier, the internal rate of return required for internal environmental investments is often different from that of nonenvironmental opportunities. Very little is invested to develop new technologies for the environmental industry because the barriers to successful commercialization are too great, the risk of shared liability is too large, and the opportunity is perceived as limited. A small number of very large U.S. companies have started divisions and subsidiaries or have spun off divisions that provide environmental products and services both internally and for sale to third parties, and were originally supported to satisfy an internal need. Most environmental companies invest only a small percentage of cash flow (or of sales), if any, in new environmental technologies.

- ***Project finance.*** Financing a project on its own merits, as opposed to funding the company doing the project, is project finance (e.g., a water treatment works or a landfill). This is an important type of structured finance, especially for infrastructure projects that comprise a large percentage of environmental products and services. Much of the resources for project finance in developing nations is made available by international lending organizations. In some cases, the ability of developing nations to obtain project finance from private sources is increased with government backing of the debt associated with these projects. International lending organizations and companies in this area of finance have increasingly incorporated environment in their decision-making processes, a sensible step, because of all the "flavors" of capital, project finance views investment in the longest time frame. Sometimes project finance capital is frozen in place for 30 years. The result is a much higher awareness of investment risks associated with the environment than one finds with the 3-month focus of listed equity capital. Project finance is relatively available for projects in the United States, in part because of the use of public-sector borrowing ability. The lack of project finance has more often been a problem for U.S. companies bidding on international projects, however, because their competitors often have greater access to private and public sources of capital.

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Several segments of the economy exert important collateral influences on the capital structure of the environmental industry:

- ***Insurance.*** The insurance industry is a critical component of the financial markets, both as a source of capital and as a source of vital services to the industry. Its companies are perhaps the most aware of environmental issues and the most active in striving to incorporate environmental variables into their products and those of their customers. U.S. insurance companies have over $2 trillion in environmental pollution claims outstanding. This sum does not include claims from weather and damage related to natural disasters.

  The insurance industry is critical in two ways. First, insurance is a vital component of doing business. Without today's myriad insurance products, industry and commerce would grind to a halt. The more expensive the price of insurance, the lower the profits to companies that purchase it. Second, the actions, products, and prices of the insurance industry influence and sometimes change corporate behavior.

The industry is also making available an increasing number of pollution-related insurance products, helping the U.S. environmental industry and its customers compete.

The insurance industry has been laboring to overcome huge losses from claims related to pollution and asbestos. Recent violent weather patterns have generated even larger underwriting losses and made the issuance of new insurance more expensive and risky. A large portion of the insurance industry now believes that this weather flux is in part caused by climate change linked to human activities. Thus, the insurance industry is active on all fronts (political, science research, economic) trying to understand environmental issues, achieve better environmental performance, and minimize exposure to further losses. The industry is also making available an increasing number of pollution-related insurance products, helping the U.S. environmental industry and its customers compete.

- ***Accountants and disclosure.*** The accounting profession has not taken a leading role in environmental issues and has tended to wait for changes to come from external pressure before acting as an arbiter or referee. Nevertheless, they are an important arbiter: As Stephan Schmidheiny said in *Financing Change*, "They are the final arbiter on what constitutes the bottom line."[42]

  Publicly held companies are required to report environmental expenditures and reserves under SEC rules and FASB requirements. But these figures generally show up in footnotes. Few established guidelines exist for the proper amount of reporting or levels of reserves to accrue against potential liabilities. There is no one standard as to what constitutes an "environmental cost." This makes it difficult for analysts and investors to accurately gauge the level of environmental risk and to make comparisons among customers of the environmental industry.

- ***Credit agencies.*** Rating agencies such as Standard & Poors, Moodies, and Duff & Phelps act as guides and interpreters of information for the financial community. Their target audience has tended to be debt investors, while the analysts target equity investors. A company's rating typically focuses more on its ability to meet its liabilities and costs than on how its potential future revenue growth will be affected by environmental costs. The rating agencies have made progress incorporating environmental costs into their analyses, but they too suffer from a lack of standardized data and procedures. Translating environmental data into information relevant to the financial markets is evolving

[42] Stephan Schmidheiny, *Financing Change*, Avena Foundation, 1995.

slowly. Most agencies use a set of questions centered on financial strength, legal actions, management systems, and regulatory exposure.

- ***Export.*** Many sources and types of capital and support are available to assist companies in the export of energy and environmental products and services. They include the Export-Import (ExIm) Bank, the Overseas Private Investment Corporation (OPIC), the World Bank, International Finance Corporation, and others. In addition, several state programs assist exporters, and it is even possible to access some non-U.S. sources, depending on the project. This part of the capital supply chain is better informed and more interested in supporting the environmental industry than most other capital sources.

2.5.2 Financing Conclusions

Problematic risks faced by the environmental industry have decreased access to the financing necessary for industry strength at a time when the overall U.S. economy is generating sufficient capital. Industry leaders feel that a combination of policy and structural issues is at the heart of the financing problem. Although unique regulatory barriers are an essential part of the problem, other issues identified above make the environmental industry's situation not unlike what has existed at the birth of many other critical industries in the United States.

Problematic risks faced by the environmental industry have decreased access to the financing necessary for industry strength at a time when the overall U.S. economy is generating sufficient capital.

For mature industries, historical qualitative and quantitative data exist for the essential performance questions asked by financial decision-makers. For the very young environmental industry, it will take time to accumulate enough experience to have well-defended answers. But as each year passes, we should be better able to answer several important questions about the customers of the industry:

- How do capital suppliers view risk, profitability, and competitiveness relative to a customer company's environmental performance? The answer to this question will not be static, and policymakers must keep alert as capital suppliers' views change.

- Will the financial markets reward better environmental performance? At this time, the reward is slight, if it is detectable at all, although the penalties for poor performance, especially in extreme situations, can be significant. Moreover, investment in resource efficiency and pollution prevention can reduce short-term profits even while increasing competitiveness and profits

over time. The U.S. market is biased in favor of short-term profits.

- Do companies with better environmental management systems have broader access to capital and lower overall capital costs? Is there a positive or causal relationship?

- How does our economic system reconcile the 3-month focus required by our publicly listed companies with the longer time horizon required to compete with companies based in some other countries, let alone help attain national sustainability goals? U.S. financial markets discount the future heavily and indirectly provide incentives for unsustainable resource consumption to maximize short-term economic gains with little regard for long-term environmental costs borne by society at large.

- Will national and international policies be changed to reflect the long-term value of resources? The language of business and finance does not reflect the *true value* of many resources. Full-cost accounting would bring the markets into better balance and create incentives for continuous environmental improvement.

The role of information—quantified data linking the financial impacts of environmental performance, definitions and benchmarking, accounting and reporting standards—is vital to attracting more capital.

Industry leaders see opportunities for policymakers to act through economic reform to catalyze the competitiveness and growth of the environmental industry. Putting a "price" on the environment and integrating environmental and resource use factors into financial markets are among the critical opportunities they see. The role of information—quantified data linking the financial impacts of environmental performance, definitions and benchmarking, accounting and reporting standards—is vital to attracting more capital. So is the ready availability of these and other data to the public to increase consumer and customer awareness. The financial community's response to the problems listed above is unlikely to change, however, without incentives unavailable under the "command and control" system, industry leaders say. Energizing this industry is a complex problem, the solution to which will use the wide variety of tools available to our country—revamped environmental regulations, tax policies, capital rates, insurance, loans, purchasing, accounting, education, guarantees, etc. Once it is reenergized, this industry can experience a renewal of growth and job creation.

2.6 Current Government/Industry Cooperative Initiatives for a Strong and Technologically Competitive Environmental Industry

The first presidential "National Environmental Technology Strategy,"[43] *Bridge to a Sustainable Future*, was issued in April of 1995. Previously, in November 1993, a group of federal agencies led by DOC, DOE, and EPA issued the first strategy in support of environmental exports, "Environmental Technology Exports: Strategic Framework for U.S. Leadership." The release of these strategic documents reflected the growing concern that environmental progress and sustainable economic growth are dependent on greater government/industry cooperation. The strategies called for several actions to stimulate competitiveness, including the following:

- Incentives in environmental regulatory structures to encourage environmentally beneficial technology innovation and use.
- Plans to restructure federal R&D investment to favor technologies that can achieve both economic *and* environmental objectives.
- Steps to increase investment of federal R&D resources in programs that strengthen the capacity of the private sector to develop and commercialize environmental technologies.
- Better coordinating U.S. government programs to expand export opportunities for American companies.

As a result of these strategies, a number of initiatives and pilot programs are testing the water for economic and environmental progress. Each attempts to address one or another of the widely perceived problems and opportunities that have been identified earlier in this chapter. Chapter 3 addresses the industry leaders' views of the more far-reaching steps needed to create the systemic change they see as necessary. The initiatives and pilots described here may be broadly grouped into regulatory and nonregulatory categories.

These strategic documents reflected the growing concern that environmental progress and sustainable economic growth are dependent on greater government/ industry cooperation.

[43] National Science and Technology Council, *Bridge to a Sustainable Future,* Washington, DC, Office of Science and Technology Policy, 1995.

A small number of market-based regulatory programs have been authorized by the Congress over the past decade and implemented by EPA and the states.

2.6.1 Regulatory Trends and Initiatives

Federal agencies, state agencies, and other organizations in the United States are undertaking several regulatory initiatives. Many are directly intended to help implement the presidential strategy, *Bridge to a Sustainable Future*. Most are pilot programs limited in extent and narrowly focused. Most prominently, a small number of market-based regulatory programs have been authorized by the Congress over the past decade and implemented by EPA and the states. Some are described briefly below.

- ***Economic, or market-based, regulations.*** Clean air programs contain economic incentive-based regulations that were authorized in legislation (e.g., the 1990 amendments to the Clean Air Act). One such regulatory approach is *tradable permits*. Perhaps the best example of tradable permits is seen in the implementation of the statutory cap of 10 million tons of sulfur emissions. Sources reducing emissions under the cap are allowed to trade or sell allowances. Their savings are expected to lower the cost of compliance by billions of dollars. In fact, rights to make future emissions have recently traded at about $80 per ton, far less than the $1,500 per ton projected by opponents during congressional debates. Another regulatory innovation is "*bubbling*," under which firms trade off tighter controls on some sources for lesser controls on other sources of the same category of pollutants within the same facility or, even, neighboring facilities. Confirmatory monitoring is required. Another innovation is *fee-based strategies*. In California, for example, the tolls on certain highways are increased during periods of heavy traffic (e.g., during rush hours) to reduce traffic and pollution. Alternatively, parking fees can be adjusted according to pollution levels or traffic volume.

  More recently, the clean water laws have been amended to introduce the first market-based authorities. And, as discussed earlier, several foreign countries have made market-based regulations important components of their environmental management systems. Experts have pointed to those in Scandinavia and Germany as being among the most successful.

- ***Information-based regulatory programs.*** A few U.S. regulations require the release of environmental information. Perhaps the best example is the Toxics Release Inventory (TRI) mandated by the Toxic Substances Control Act. It requires companies to publicly disclose information about their use or production of wastes containing specified toxic chemicals. Many companies initially

criticized this program, which placed no limits on the amounts of toxics that could be used or produced, but which exposed companies to greater public scrutiny. Many firms have since stated, however, that this program created an incentive for them to gain greater control of their use and production of toxic chemicals and wastes, and indeed, to reduce them. Some critics note that wise use of this information is not guaranteed. Some companies try to avoid public criticism by reducing the *volume* of toxic chemicals they use and wastes they produce, but do little to reduce *risk*. In other cases, public outcry about TRI release information has seemed to be more related to the volume of TRI chemicals than to the risks associated with them.

- ***Compliance flexibility.*** In 1996, EPA announced the first incentives for the use of innovative technologies by companies under compliance agreements. In agreements to settle violations, companies that agree to use pollution prevention techniques to gain compliance are given technical assistance and are granted abatement of the penalty portion of their fines if they also agree to improve their environmental performance beyond minimal compliance. This practice allows the companies to use the penalty monies to invest in technologies that are both economically and environmentally beneficial.

- ***Third-party auditing of environmental results.*** EPA, states, and companies are evaluating the effectiveness of independent, third-party auditing of compliance status. These audits could replace governmental compliance audits, if the evaluation shows that they are a viable alternative. The result could encourage agencies to focus more on outcome and on noncomplying facilities.

EPA, states, and companies are evaluating the effectiveness of independent, third-party auditing of compliance status.

- ***Streamlining permitting and approval programs for new environmental technologies.*** EPA is exploring opportunities to streamline permitting and approval programs for new technologies. Although no new permitting initiatives have been announced, steps are being taken to expedite the process for certification of new monitoring methods and analytic techniques for environmental samples.

- ***Project XL and the Common Sense Initiative.*** Through EPA's Project XL (Excellence and Leadership), EPA, states, and companies are testing a new approach to environmental management intended to encourage industry to find innovative ways to

achieve environmental goals. Companies are required to reduce pollutant discharges beyond current regulatory standards in exchange for greater flexibility in achieving the objectives. The first XL project was announced in December of 1996. It involves the Intel Corporation and the State of Arizona. Six more XL projects are in the implementation and evaluation phase, and nine more are in development as of March 1998. Another 30 have been rejected or withdrawn.[44]

In the Common Sense Initiative (CSI),[45] EPA is working with entire industries to coordinate regulatory policies across the environmental media, improve compliance, and stimulate environmentally beneficial technology change. The CSI approach is also applicable to discrete geographic areas with many pollution sources (e.g., river basins). If officials and regulated parties have not been able to achieve acceptable environmental quality despite substantial compliance, the CSI process offers the potential to allocate allowable pollution and limit the excess. CSI projects have focused on six industries to date, including automobiles, computers, steel, metal finishing, petroleum, and painting.

Several federal, state, and other nonregulatory initiatives are under way to facilitate the development, commercialization, and diffusion of innovative technologies.

2.6.2 Nonregulatory Initiatives Supporting the Process of Technology Enhancement

Several federal, state, and other nonregulatory initiatives are under way to facilitate the development, commercialization, and diffusion of innovative technologies. These, too, may help implement the President's strategy. In addition, EPA and other environmental agencies have implemented a few other initiatives over the past decade. Some have been significant.

- ***33/50 program.*** EPA's 33/50 program encouraged companies to reduce emissions voluntarily by 33% in 1992 and by 50% by 1995 (from 1988 levels). Its goals were achieved in advance of the targeted schedule. Many companies have described 33/50's technology-enhancing effect. Several have stated that their *internal* use of 33/50 information was helpful in identifying opportunities for making raw material, process, and product changes. These changes reduced their consumption and production of chemicals and wastes targeted by the program.

[44] See www.epa.gov/ProjectXL for more information on Project XL.

[45] See www.epa.gov/commonsense for more information on the Common Sense Initiative.

- ***Information-based programs.*** EPA and entire industries have collaborated on several information-based programs intended to produce technology change.[46] The Climate Wise program helps companies find innovative ways to reduce emissions of greenhouse gases. The Design for the Environment program encourages industries to identify alternative technologies that provide economic and environmental advantages by incorporating environmental considerations into the design of products and manufacturing processes. It then encourages individual businesses in the industry to adopt these technologies, if they are advantageous. The Energy Star Buildings program helps owners of commercial and industrial buildings cut energy costs. The Energy Star Computers program encourages computer manufacturers to build in equipment that reduces power use automatically when products are not in use. The Green Lights program provides on-site technical guidance to encourage the switch to energy-efficient lighting. And the WasteWise program promotes cost-effective steps to reduce the amount of solid waste generated by businesses.

- ***Manufacturing Extension Partnership.*** DOC's National Institute of Standards and Technology administers the Manufacturing Extension Partnership (MEP), with centers around the country. MEP couples technical assistance and information about advanced technologies—including those that provide environmental solutions—to promote competitive companies in U.S. industries populated with small manufacturers. MEP centers provide technical assistance through manufacturing specialists and strategic alliances with third-party service providers. The MEP network is committed to delivering practices and technologies that can create high performance among small manufacturers, including continuous environmental improvement. The network of centers identifies advanced technologies, provides training to manufacturing specialists, and helps the small manufacturers obtain technological advice that they can use to improve their competitiveness. MEP has developed specific tools and services to meet the dual goals of competitiveness and environmental excellence.

The MEP network is committed to delivering practices and technologies that can create high performance among small manufacturers, including continuous environmental improvement.

[46] Adapted from National Science and Technology Council, *Bridge to a Sustainable Future*, *op. cit.*, page 29.

- ***Rapid Commercialization Initiative.*** The Rapid Commercialization Initiative (RCI) combines the efforts of several federal and state agencies to demonstrate that they can, together, help the private sector accelerate commercialization of environmentally beneficial technologies. Through this program, ten companies are gaining government assistance in overcoming three barriers believed to be among the most important in slowing the commercialization process:

  - Lack of public and private sites at which the performance of nearly commercially available technologies can be tested.
  - Lack of procedures for verifying the performance capability and cost of performance of the commercial prototypes or the first commercial units of these technologies (see below).
  - Inability to obtain testing permits quickly or at all from state and local regulatory agencies.

  A competitive process was used to select the ten participating companies. RCI project teams, the members of which are representatives of the participating agencies *and* the company, help with all or some of the following functions: identify a site for testing, develop a test protocol, obtain environmental permits needed for testing, verify performance during the test, obtain initial operating permits needed for first uses, and disseminate results. The intent of RCI is to learn whether these specific services significantly accelerate commercialization, how the regulatory agencies can work better together for this purpose, what other services are needed to make RCI a more effective tool for accelerating commercialization, and how to embed facilitation of commercialization into governmental environmental programs.

Performance verification can significantly accelerate the commercialization of new environmentally beneficial technologies and their acceptance by regulators, potential customers, the financial community, and the general public.

- ***Performance verification for new environmental technologies.*** Performance verification can significantly accelerate the commercialization of new environmentally beneficial technologies and their acceptance by regulators, potential customers, the financial community, and the general public. Vendor claims for technology performance, no matter how valid, are rarely accepted by any of these stakeholders. A verification system with universal coverage and adequate capacity to meet demand could yield independent, credible performance data to ease the issuance of operating permits. Some industry leaders have expressed the concern that

verification must *enable* the environmental marketplace, and not *bottleneck* new technologies by creating a new source of delay and expense to technology developers.

The first and largest U.S. performance verification program is the State of California's Certification Program for Hazardous Waste Technologies, which includes technologies that prevent hazardous waste from being formed. The program began in 1994. By the close of 1996, the California EPA's Department of Toxic Substances Control had certified or verified the performance of nearly 50 technologies. (A certification issued by this program conveys the right to use a technology for its intended purpose anywhere in the state. Verifications, which the program also issues, attest to the credibility of the performance data, but do not convey the right to use.) In 1995, the state legislature approved a similar program for technologies that manage air pollution.

Other verification programs have been initiated by the U.S. EPA (the Environmental Technology Verification [ETV] pilots, the Design for the Environment program and the Superfund Innovative Technology Evaluation [SITE] program) and the Department of Defense. EPA describes the SITE program, which began in 1986, as one developed to conduct field demonstrations and performance verifications of certain innovative treatment and characterization technologies. The data and reports generated by the program are used by decisionmakers in selecting treatment options and for increased credibility in innovative technology applications. As of January, 1998, the SITE program has completed 95 treatment and 37 characterization demonstrations. Technology vendors over a 6-year period have reported 1,895 contract awards after participation in the SITE program. EPA notes that the percentage of these vendors reporting revenue between 1988–1996 is 59%, which it believes to be a high rate of success for innovative technologies.

The most recent verification program put in place by EPA is the ETV program. ETV is the most comprehensive of EPA's verification programs and covers all areas not covered by SITE or the Design for the Environment program. In its first 2 years of operation ETV has completed performance verification of 12 technologies, and 35 others are now in process. EPA has stated its intention to have the ETV pilot cover the entire range of environmental technologies.

Verified data are of little value unless state and local regulatory personnel accept that these data establish application-specific technology performance.

The Interstate Technology and Regulatory Cooperation Work Group (ITRC), sponsored by DOE and the Western Governors Association, is seeking to build a national verification system by facilitating reciprocal recognition of verified performance data among state regulators and EPA. Verified data are of little value unless state and local regulatory personnel accept that these data establish application-specific technology performance.

Under ITRC, six states (California, Massachusetts, New Jersey, Illinois, New York, and Pennsylvania) are working together to obtain reciprocal recognition of one another's verified performance data. The group intends to strengthen the basis for reciprocity and expand the coverage of the reciprocity agreement to other states. The group has also stated its intent to develop an overarching guideline that establishes requirements for performance data generated during tests that it will recognize as credible. This so-called "universal protocol" is needed to ensure that the performance of all types of environmentally beneficial technologies can be verified and to allow comparison of performance of technologies that have fundamentally different operating principles but which are intended to solve the same problem. (For example, a single environmental problem could be solved by applying an end-of-pipe control technology, by treating resulting wastes, or by preventing formation of the pollution through an enhanced production technology.) Universal coverage of environmental technologies and recognition of the results, along with adequate capacity and reasonable cost, will make verification truly market enhancing, industry leaders say.

- ***The Advanced Technology Program (ATP), the Partnership for a New Generation of Vehicles (PNGV), and other research collaboration models.*** ATP is a DOC-led initiative that offers cost-share awards to industry for the development of high-risk enabling technologies with significant commercial potential. The program fosters R&D cooperation between governmental and industry experts and technology sponsors. Individual companies and industry-led joint ventures may compete for awards. Selections are made through a peer-reviewed competitive process that integrates technical and business factors to increase the chances for success. Both private and government experts participate in the review process. ATP accelerates progress on technologies be-

lieved to be promising from both a technical and a business perspective and that otherwise might not be developed quickly enough to meet marketplace needs. The program has sponsored competitions for precompetitive technologies. Spillover environmental benefits may arise from technologies sponsored by the program, both in its focused programs and general competitions.

The DOC-led PNGV provides a mechanism for collaborative, cost-shared research in high-risk areas of technology development related to the automobile. It also links companies doing research in this area to relevant expertise resident in the federal laboratory system. Through these means, PNGV facilitates companies' achieving what they could not achieve on their own. The PNGV program has made environmental improvement a specific goal (achievement of "Tier 2" emission standards). Similarly positive R&D programs include DOE's Industries of the Future program and the Department of Defense's Environmentally Conscious Manufacturing Consortium.

3. Challenge for the Future: Competing in Dynamic Domestic and World Markets

The U.S. environmental industry is at a turning point. Industry leaders and many of their customers suggest that the next few years will be pivotal in light of evolving domestic needs, strong competition for a static level of U.S. demand, and rapidly growing international environmental markets. The primary choices rest with the industry itself. Either the industry will passively await new regulations and quasi-regulatory market stimuli or it will find new products and services that offer added value to its customers. This chapter outlines the present and future competitive response that industry leaders believe will be necessary in a market in which economic motivators are becoming increasingly important to their customers and the public.[47]

Either the industry will passively await new regulations and quasi-regulatory market stimuli or it will find new products and services that offer added value to its customers.

Industry leaders believe, as well, that the government must act to shape the market climate in which the industry must compete. This chapter reviews recent governmental policy initiatives in support of the environmental industry. It then outlines industry leaders' agenda for a two-track strategy for making crucial reforms in the federal-state system of environmental policies and regulations. Systemic policy and programmatic changes are, in their view, essential to the necessary replacement of the "command and control" system with regulations that emphasize environmental performance, deemphasize administrative process, reward environmental excellence, and penalize failure. They believe these changes will also encourage the marketplace to develop, commercialize, and use new technology-based products and services that convey economic and environmental gains.

Industry leaders see five major areas of action by their companies and government as being particularly important to the industry's future competitiveness:

- ***Offer new, value-added environmental products and services.*** Customers' adoption of new process technologies, "strategic environmental management," ISO 14000, and other methods that link environmental performance with overall business strategy are beginning to reshape demand for the products and services of the environmental industry. Environmental companies must encourage this trend, with reinforcement by government agencies.

[47] In this portion of the report the Department of Commerce is *reporting* the policy views of industry leaders and, at times, their customers. These views are not necessarily those of the Department of Commerce.

OFFICE OF TECHNOLOGY POLICY

Government agencies are experimenting with new policies that reward and encourage excellence in environmental performance. Industry leaders say that some of these policy directions are essential to engaging the market to both benefit the environment and enhance national competitiveness.

- ***Reform government policies to stimulate the environmental market.*** Government agencies are experimenting with new policies that reward and encourage excellence in environmental performance. Industry leaders say that some of these policy directions are essential to engaging the market to both benefit the environment and enhance national competitiveness. They do *not* argue for new rounds of regulations. Suggested government reforms can be generally grouped into three areas: replacement of the regulatory "command and control" structure, reform of government's own environmental management activities, and revamped government support for technology development and diffusion. These business leaders and many of their customers see *systemic change*—rather than more experiments, initiatives, and pilots—as critical. They envision replacing "command and control" regulation with two types of policy mechanisms: performance-based regulations and information-based mechanisms.

- ***Revamp government environmental technology-related research and development (R&D) programs.*** To reinforce new market-enhancing regulatory strategies, industry leaders propose a two-edged redistribution of governmental technology-related R&D resources. Technology development resources would be shifted toward technologies that may contribute to a more sustainable economy *and* environmental technology R&D resources would be increased for programs in which the government—federal, state, and local—facilitates R&D and product development by the private sector and nongovernment organizations. They suggest that these steps would increase both related private-sector R&D and taxpayers' return on government R&D investments in the United States, leading to new environmentally beneficial products and services.

- ***Improve government/industry cooperation to expand environment-related exports.*** Industry leaders focus on the need for greater cooperation on environmental exports as a step that will directly influence the ability of the U.S. industry to contribute to environmental gains worldwide.

- ***Value the environment in national and international economic systems.*** The free exploitation of the environment has been imperfectly replaced by highly variable regulatory-based pricing. Industry leaders point to the inefficiency and ineffectiveness of this strategy in the United States and internationally.

OFFICE OF TECHNOLOGY POLICY

Industry leaders note that the influence of governmental management of monetary and fiscal policies is a second important force in the environmental market, along with environmental policy. Government involvement in this marketplace thus is multidimensional. Tax policies, government R&D investment strategies, government expenditures on environmental services, intellectual property policies, and environmental regulatory policies and programs, for example, all exert major influences on the development and deployment of environmentally relevant technologies, as well as in the pollution sources these technologies are designed to mitigate. Further, the prevailing standards of accounting practices for purchases and investments and for income and expenditures—which are *not* mandated by government—influence our perception of the condition of the economy. These policies and systems, *as they are*, shape the environmental marketplace.

Thus, industry leaders feel that it is a mistake to suggest, as some do, that any new economic or regulatory policy aimed at improving the environment would create an *improper* government intrusion. New government policies may involve simply getting out of the way. And, new policies could take advantage of our growing understanding of governments' influence on economic behavior to find ways to improve the government-industry partnership for a sustainable economy. The opportunity and need for *more effective* government policies is nowhere more apparent than in the relationship between government and industry for the environment and the economy.

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Anecdotal evidence that alternative policies could simultaneously improve economic and environmental performance has grown in recent years. This evidence, which contradicts earlier experiences that environmental expenditures are always a drag on productivity and the financial performance of companies, has stimulated a spirited debate about government environmental and economic policies. Now, as discussed in Chapter 2, statistics about corporate economic and environmental performance establishes their relationship to companies' patterns of technology innovation, deployment of technologies, and organizational and decision-making choices on economic and environmental performance. These statistics enhance our ability to examine the relationship between government policies and private-sector strategies, and support policy proposals suggested by the environmental industry.

The development and use of environmentally beneficial technologies suffer when government policies and programs send conflicting or negative signals to industry. A sound base of information about the

development and adoption of advanced productive technologies now exists for the first time, at least for larger firms. Governmental policies that relate to the environment and to technology can now be examined with an eye to (1) engaging the market process systematically for the environment, (2) facilitating companies' efforts to overcome "Valley of Death" problems, and (3) increasing public benefits from government-funded technology R&D related to the environment.

3.1 Reinvention of the Environmental Industry

For environmental companies, the foremost opportunities arise from linking environmental improvement with their customers' overall business strategies.

For environmental companies, the foremost opportunities arise from linking environmental improvement with their customers' overall business strategies. By pursuing this strategy, environmental companies can, as noted by Richard Florida, create "new opportunities for joint improvements in productivity and environmental outcomes."[48] As environmental firms move from the technical to the business sphere, their competitiveness, their reputation with their customers, and their financial results can change dramatically and usually for the better. This section describes how industry leaders say their industry can thrive under the parameters of the emerging environmental business, both overall and differentiated by sector. It also examines the ways in which several integrative approaches are advantageous domestically and internationally.

3.1.1 Offer New, Value-Added Environmental Products and Services

The parameters of competition are changing, and the future competitiveness of the industry will center on its ability to deliver value rather than simply fix problems. Increasingly, it needs to sell productivity *plus* compliance, business solutions *and* environmental solutions. In a broad context, an opportunity exists for environmental companies to become *resource* managers as well as *environmental* managers, more fully integrating their products and services with the core business interests of their industrial and government clients. In addition, many industry leaders understand that they must develop a collective voice on environmental policy. They express the view that the industry is a missing but critical third voice in the formation of environmental policies of the future, along with environmental advocacy organizations and regulated communities. Their voice, in their view, is both pro-environment *and* probusiness. The leaders believe their companies should select from the following set of strategies as they strive to enhance their competitiveness:

[48] Florida, *op. cit.*

- ***Leading the transition.*** Factors for business success change along with fundamental changes in the market and its motivators. Successful companies are those that participate in and lead the change and don't wait to react to its consequences. The largest changes facing the environmental industry are the shift of its customer demand and the transition to economic policies. These changes will also be the foundation for sustainable development. As customer environmental decision factors expand to embrace core business objectives, and as economically based policies emerge that internalize the social cost of pollution, environmental degradation, and unsustainable resource extraction, the companies with the tools to demonstrate the economic value of environmental investments will be the most competitive.

- ***Taking an active role.*** If the past mark of competitiveness in the environmental industry was technical competence to meet a regulatory requirement, then the future of competitiveness is a set of integrated services and technologies that provide enduring business solutions with demonstrated economic value. With government and generators of waste and pollution assuming new approaches in environmental management outside of the "command and control" paradigm, environmental firms must more actively drive their market. Solely reacting to customer needs—and competing on price and quality—will not sustain competitive advantage.

- ***Providing long-term solutions.*** The customer transition to a more "strategic environmental management" approach demands long-term solutions from product and service providers, not just isolated sales. Client project demands are greater and more integrated, commanding fewer isolated technical fixes and more full-service, or "turnkey," project management. Environmental companies must evolve from assessors and designers of solutions for environmental problems to builders and operators of resource management systems. Technologies developed in isolation from the market and without price and value consciousness will rarely succeed in these new and evolutionary markets. An example would be progressing from merely designing a wastewater treatment discharge system to designing and operating a wastewater treatment/water purification recycling system that would save water use and wastewater discharge fees.

Client project demands are greater and more integrated, commanding fewer isolated technical fixes and more full-service, or "turnkey," project management.

- ***Turning costs into investments.*** Consumers of environmental services and technologies traditionally view their expenditures as costs whose only effect on the bottom line is negative. Effective application of environmental technical expertise, however, frequently provides a benefit in productivity and resource efficiency. These benefits are not always immediately apparent. Environmental companies must market the value of their product and service offerings and position them as investments rather than costs. Calculating a return on investment (ROI) for the customer puts the vendor in the right frame of mind for creating an enduring business relationship—more so than stating the cost of gaining regulatory compliance. Responding to requests for proposals with a statement of qualifications (SOQ) is insufficient in a competitive market, and those sticking with the old system of competing over regulatory-driven business are falling by the wayside. The new paradigm of environmental marketing changes "Here's my SOQ" to "Here's your ROI!"

Clearly, pollution prevention is central to turning environmental costs into investments. Pollution and waste generation, after all, are nothing but manifestations of inefficient use of resources.

- ***Preventing pollution.*** Clearly, pollution prevention is central to turning environmental costs into investments. Pollution and waste generation, after all, are nothing but manifestations of inefficient use of resources. The declining influence of regulations portends the transition from an industry founded on cleanup and control to one focused on process and prevention. Specialization must be transitioned from particular waste streams and media (e.g., water, air) to customer types and industrial processes. An example of this new framework for an environmental solution is making a pulp and paper process more efficient, not just solving a water pollution problem.

- ***Benefiting from outsourced environmental management.*** Organizations that generate pollution are increasingly contracting out environmental compliance and resource management functions to a full-service provider rather than hiring internal environmental staff. By outsourcing these functions, companies focus on their core competencies. Cost-efficient environmental management will vary from company to company, but the opportunity is apparent for those environmental companies that offer complete solutions, not just technical expertise. If environmental companies want a competitive edge, they must calculate where their services will be most cost-effective—and have the highest potential to add value—for the client.

- ***Using technology to differentiate.*** The new environmental solutions demanded by corporate customers will rely increasingly on technology-based systems rather than specific services rendered. These systems will use such techniques as pollution prevention, on-site treatment, monitoring, and auditing. An example of this shift is the trend away from sampling and off-site laboratory analytical testing and toward on-site instrumentation and data processing systems, including real-time feedback to process controls. The focus on cleaner processes has already eroded the business of a number of environmental firms. The common thread is industry-specific process technology and materials science. Service providers are not quite ready to pass the torch of leadership in the environmental industry over to process and prevention technology companies, although the need is apparent for environmental service firms to access and leverage a technology edge through research facilities, entrepreneurs, and strategic partnerships. If they don't, their customers will access that technology first—and in many cases (particularly the leading edge companies identified by Florida), they already have.

- ***Meeting the global challenge.*** The global need for environmental products and services is dramatic. Translating this need into firm orders, however, requires a considerable adjustment for an environmental industry so strongly rooted in the U.S. market. To be competitive, the industry has to reinvent itself. Parameters of demand are considerably different even in the developed markets of Western Europe and Japan, where regulations and regulatory processes, when they do play a role, are considerably different. In developing nations, much of the market revolves around developing environmental infrastructure systems for drinking water, sewage treatment, and waste collection and disposal. Most U.S. companies have grown up with environmental infrastructure in place, and developing these systems from the ground up (facing financial, political, social, labor, and technical issues) is not part of their experience base.

The global need for environmental products and services is dramatic. Translating this need into firm orders, however, requires a considerable adjustment for an environmental industry so strongly rooted in the U.S. market.

3.1.2 Different Segments Face Different Competitive Factors

While some competitive factors apply to many or all segments of the industry (e.g., the need to turn the cost of environmental solutions into investments in competitiveness that also avoid or solve environmental problems), others apply more narrowly to one or a few sectors. Each segment of the U.S. industry faces a unique set of competitive factors. Some examples are discussed below:

As environmental regulations based on set standards transition into performance-based standards using economic instruments, instrumentation and data systems will need to accurately measure the required parameters.

- ***Equipment providers must sell integrated systems.*** The largest challenge for environmental equipment providers has frequently been to integrate their pollution control devices into a treatment system or even to integrate them into an industrial process. The prevalence of small providers selling single technologies commonly meant that they had to depend on the internal capabilities of their clients, or their consultants, to design in their particular piece of technology. To address this issue, companies—and teams of companies—must offer a one-stop approach to equipment, systems design, construction, and operation, as exemplified by at least one of the leading U.S. environmental companies, US Filter Corporation. US Filter has pursued a consolidation strategy in the water business and has grown from revenues of $20 million in 1991 to $2 billion in 1997 by becoming an integrated supplier of water-related, technology-based services. Few companies can follow the same track, but equipment companies large and small must ally themselves with complementary providers to offer complete solutions to their customers.

- ***Analytical firms must provide answers not just data.*** Providers of environmental testing services and instruments must move away from isolated testing to continuous monitoring and data reporting systems. This approach allows decisionmakers to productively translate the ongoing stream of environmental data into intelligence. As environmental regulations based on set standards transition into performance-based standards using economic instruments (e.g., discharge fees based on contaminant volume), instrumentation and data systems will need to accurately measure the required parameters. Likewise, as environmental performance becomes self-reported and then audited by environmental authorities, demand will shift to more effective monitoring technologies.

- ***Waste firms must develop resource potential***. Increasingly, the $34 billion solid waste business and the $6 billion hazardous waste business in the United States must turn their attention from finding cheaper ways to bury or burn waste to finding economic value in the waste streams these industries collect. Recovered material sales already account for $14 billion in the United States, but this figure could conceivably one day eclipse the combined waste management revenues. Aggressive recycling targets have been set in many cities and states, and governments have made a significant demand-side contribution by procuring recycled-

content materials. However, demand and prices for recycled materials remain highly cyclical, making investments in resource recovery businesses suspect. Policies that subsidize the continued exploitation of virgin resources persist in some areas. Balancing these subsidies would improve the economics of recycling.

- ***Cleanup firms must focus on value of property.*** Remediation firms have traditionally relied on the regulatory hammer of EPA's technical requirements on contaminant concentrations in soil and groundwater to drive their business. The new paradigm of competitiveness in remediation is cleanup for economic development, rather than for regulatory compliance. So-called "brownfields" are usually properties that are not severely contaminated. Many of them will be remediated to recover the economic potential of the land they sit on. In some cases, brownfields projects turn contaminated sites into partially clean properties to permit their limited, rather than unrestricted, economic use (e.g., as industrial sites but not for schools or residential development). In such projects, remediation firms have significant opportunities to partner with property owners, developers, banks, insurance companies, local authorities, and others interested in revitalizing underutilized assets.

The new paradigm of competitiveness in remediation is cleanup for economic development, rather than for regulatory compliance.

- ***Water infrastructure must embrace privatization.*** Roughly 90% of the water delivery and wastewater treatment infrastructure in the United States is publicly owned and managed. Few municipalities have the motive of profit to invest in efficiency or innovation in their systems, even though such investments ensure public safety. Overall, America's water infrastructure is in sore need of upgrade, and it seems unlikely that public funds will be available in sufficient quantity to meet the task. An important alternative approach to these problems is to allow and encourage private management or even ownership of these assets. Not only would privatization offer the potential of better water at a cheaper price with more direct accountability to the customer, it would also enable U.S. water management companies to compete for international projects.

3.1.3 New Economic Rules for Competitiveness: Strategic Environmental Management

Industry leaders foresee the time when regulations take a back seat as the predominant impetus for the purchase of environmental products and services. The new impetus will increasingly be economics, although

it is apparent that the adoption of broad-ranging market instruments will not occur overnight. To industry leaders, the law of diminishing returns is apparent in the application of new environmental regulations. Each new regulation has marginally less benefit to society and the environment. Environmental companies must find business opportunities in environmental efficiency through pollution prevention, product design, process engineering, and resource recovery. Here will lie their most compelling opportunities as economic policy evolves to value the environment.

Corporations need a strategic orientation for their environmental management activities, integrating all of their environmental costs with corporate productivity investment strategies. Strategic environmental management provides a vehicle for this approach, enabling large corporations to "play offense" on environmental issues, creating competitive advantages rather than merely "playing defense" by forestalling costs and avoiding litigation. Strategic environmental management (SEM) can aid the transition from tactical environmental compliance to proactive environmental strategy conducted on an integrated basis with the drive for economic competitiveness in businesses.

Strategic environmental management (SEM) can aid the transition from tactical environmental compliance to proactive environmental strategy conducted on an integrated basis with the drive for economic competitiveness in businesses.

Shifting the focus of environmental management away from regulatory compliance toward competitive advantage is still a novel concept. Vendors offering SEM services to help clients make this shift, have, at most, only a few years of experience in this field. But markets develop fast, and many firms in two important segments of the industry—environmental consulting and engineering (C&E) and management consulting firms—have grown more confident in their ability to deliver SEM support to clients whose demands to integrate environmental concerns across the business planning spectrum are growing ever more sophisticated.

Some of what is defined as SEM services is repackaged traditional C&E services such as audits, regulatory impact assessments, training, and compliance reviews. But some environmental consulting firms are designing new types of services to support SEM: risk assessment, waste minimization, financial reporting, ISO 14000 support, full-cost accounting, life-cycle analysis, total quality environmental management, environmental information systems, and other tools.

Vendors already active in this still relatively uncrowded market believe growth looks promising. The 25 respondents to a survey by *Environmental Business Journal* (EBJ) on SEM practices had collective SEM revenues of $349 million in 1995 but expect to nearly double that total to $645

million in 3 years. EBJ's estimate of the 1995 SEM market was $900 million as a subset—and an increasingly important business subset—of the $15.5 billion U.S. environmental C&E engineering market.

EBJ's survey of SEM practitioners found that, for now, traditional elements (e.g., waste minimization audits and regulatory impact analyses) contribute more to the SEM revenue mix than such newer practices as benchmarking, competitive advantage analysis, and full-cost accounting. However, the former elements are expected to diminish in relative importance. Easily the biggest anticipated increase in SEM services surrounds ISO 14000, which accounted for 2% of SEM service revenue in 1995, but is expected to rise to 11% in 1997 results.

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More than 40 environmental codes of conduct exist worldwide, including British Standards 7750, the emerging European Union Ecomanagement and Audit Scheme, and the CERES principles, not to mention numerous industry-specific guides such as the chemical industry's Responsible Care program. The standard with the greatest international impact, by far, is ISO 14000, a series of environmental management standards being developed by the International Standards Organization (ISO).[49] ISO 14000 is intended to avoid international trade barriers that could result from conflicting national environmental management standards. Environmental companies cite ISO 14000 and the globalization of business as the most compelling nonregulatory factors driving their business today.

Generally, SEM vendors agree that environmental leaders don't have to be large companies and don't have to belong to a particular industry. Nevertheless, most work still comes from the most heavily regulated, traditional environmental clients. While there was no clear leading industry in terms of the generation of SEM sales, there is a clear top four: chemicals, oil and gas, manufacturing, and pulp and paper. Another EBJ finding—one that reinforces the conclusions of Carnegie-Mellon/Harvard—is that rather than pointing marketing efforts at specific industries, SEM business developers may be better off determining whether potential clients can be classified as leaders, proactive, reactive, or laggards in their environmental and strategic management philosophy.

Executives responding to the EBJ survey were optimistic that SEM has enough momentum to sustain growth in a period when the impact of regulations is not strong. One noted that regulatory changes won't affect the SEM business because "industry has shifted from reactive to proac-

[49] See note 18.

tive" and its "drivers are economic." Others commented that SEM is more dependent on "the ability to deliver bottom-line value," and "We don't intend to let regulations drive these services." One respondent posited that "regulatory uncertainty stimulates SEM, but a rollback would dampen demand." Others cited the impact of new order regulations, such as Title V and III of the Clean Air Act and risk-based cleanups, and nonregulatory approaches, such as voluntary EPA initiatives and ISO 14000, as positive for SEM.

Clearly SEM has an international and business footing that protects it somewhat from damage that regulatory and enforcement rollbacks could inflict. But environmental executives believe that if the influence of regulation weakens, SEM strategies will lose some of their impetus. The original impetus for SEM was regulatory—with proactivism rewarded by avoiding penalties, improving public image, and staying off the Toxic Release Inventory top 10 or top 20. "I wish we were a little further along in terms of incorporating SEM into corporate culture," said one provider of SEM services. "I think there's enough of a beachhead that it will continue, but the process could be slowed down." Congress is essentially "barking up the wrong tree by trying to get regulations repealed. What people really want is more flexibility in achieving environmental goals. If [Congress] cottoned on to this, it would play right into SEM."

3.1.4 Accounting for Environmental Costs: Linking Environment With Business Strategy

As the basics of environmental policy and management are put into place at leading corporations, the overriding preoccupation today, as we have seen, is to link environmental performance to financial performance (see section 3.2.1). Making this link has been an ambition for years, but only now are the tools and infrastructure in place to take the first steps.

Environmental costs associated with raw material usage, manufacturing processes, product design, and R&D have been obscured by conventional accounting practices and hidden in labor, maintenance, and other types of overhead.

One of the critical missing links has been the ability to account properly for environmental costs. Costs associated with raw material usage, manufacturing processes, product design, and R&D have been obscured by conventional accounting practices and hidden in labor, maintenance, and other types of overhead. Recent research has revealed the degree to which these environmental costs have gone unaccounted for. The book *Green Ledgers: Case Studies in Corporate Environmental Accounting*[50] found enormous discrepancies between perceived and real environmental costs. At Amoco's Yorktown refinery, for example, costs were estimated at 3% of noncrude operating costs. Upon closer scrutiny, that estimate

[50] World Resources Institute, *Green Ledgers: Case Studies in Corporate Environmental Accounting,* Washington, DC, 1996.

rose to 22%. The more that the dispersed nature of environmental costs is reconciled, the more easily firms will commit to an integrated, corporatewide management approach. More importantly, when accurate accounting highlights real environmental losses, investment can be more strategically targeted—and its impact measured and integrated more closely with business strategy.

The necessity of a recognized system for integrated accounting is not limited to industry. Governments have been woefully lacking in establishing national accounts which consider changes in the value of the environment and the natural resource base, as well as the negative economic effects of pollution, waste generation, and resource consumption. The environment is still often economically regarded as a free good with consumers bearing little economic consequence for its use and abuse. Clearly this situation must be rectified from a policy standpoint for the sake of the sustainability of national economies and the environment. Once it is, economic validation will be evident for application of the talents and technology of the U.S. environmental industry.

3.2 Revamping Government Policies and Initiatives to Enhance the Competitiveness of the Environmental Industry

Industry executives and many of their customers identify several essential steps government must take to stem deterioration of the compliance-driven market, address the business needs of regulated organizations, and respond to the globalization of demand. They do *not* argue for new rounds of regulations. They see *systemic change* in regulatory and nonregulatory policies and programs, rather than the addition of more initiatives and pilots, as critical to an efficient environmental market and a competitive environmental industry. These changes can generally be grouped into four areas:

- Replacement of the regulatory "command and control" structure.
- Reform of government's own environmental management activities.
- Revamped governmental support for technology development and diffusion.
- Other nonregulatory steps.

Industry executives and their customers see systemic change in regulatory and nonregulatory policies and programs, rather than the addition of more initiatives and pilots, as critical to an efficient environmental market and a competitive environmental industry.

All four changes are needed to reverse the barriers and other factors discussed in Chapter 2 that contribute to the financial risks hampering the industry's competitiveness. In addition and in the longer term, industry leaders suggest that government must influence the market by accurately reflecting environmental costs in business and national accounting systems.

3.2.1 Creating Regulatory Incentives That Stimulate Environmental Markets by Removing "Command and Control" Barriers

Industry executives and many of their customers believe that a two-track strategy for systemic reform of the federal-state system of environmental policies and regulations is essential. They do *not* argue for new rounds of "command and control" regulations to boost their lagging market. Rather, this technologically prescriptive, process-oriented system should be supplanted. The new approach, in their view, must be based on effective integration of their customers' environmental and economic concerns, and on the link between resource efficiency and competitiveness. They feel that steady compliance processes are necessary to hold regulated companies accountable for their environmental performance. Companies should be encouraged to manage environmental outcomes as a part of their normal business decision-making processes and to seek integrative, multimedia solutions. This approach (building on the direction of such EPA experiments as Project XL and the Common Sense Initiative) will create incentives for environmental excellence and the use of innovative industry products and services to make environmental performance a positive competitive factor.

Companies should be encouraged by regulations to manage environmental outcomes as a part of their normal business decision-making processes and to seek integrative, multimedia solutions.

These improvements, as noted by Banks and Heaton,[51] should be "a renewal, not a rollback." They argue that "the promotion of technological change" should become "the central instrument of environmental policy." In 1993, the Interagency Environmental Technologies Exports Working Group stated that "removing the obstacles which erode U.S. technological competitiveness in this sector and continuing to maintain a strong environmental policy program will foster a dynamic environmental technology industry."[52] Industry leaders say it is critical that environmental regulatory processes promote development, commercialization,

[51] Banks and Heaton, *op. cit.*, page 51. See also the Environmental Protection Agency advisory committee reports, *op. cit.*; the Office of Technology Assessment study, *op. cit.*; and other sources.

[52] Interagency Environmental Technologies Exports Working Group, *Environmental Technologies Exports: Strategic Framework for U.S. Leadership*, November 1993. This effort was led by the departments of Commerce and

and use of these new technologies. To do this, the regulatory process must make systematic use of market mechanisms to strengthen demand for innovative solutions and must enable the processes of technology innovation and implementation.

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Industry leaders suggest two principles to guide these policy and regulatory reforms:

- Maintain a firm regulatory baseline, though *without* the barriers inherent in "command and control" and *with* strong enforcement, to define the "floor" for environmental progress, offer problem-solving flexibility, and sustain a legal mechanism for penalizing environmental violators.

- Shift from "command and control" regulatory approaches to a primary reliance on performance-based and information-based policies. The purpose of this shift is to achieve two results: (1) rewarding environmental excellence and creating incentives for environmental performance above the floor, and (2) encouraging companies to integrate the environment into their core business decisions (e.g., through lower transaction costs related to compliance and greater flexibility to achieve environmental results simultaneously with other business objectives).

These principles, embedded in systemic policy and regulatory changes, will foster an integrated pursuit of economic efficiency, increased productivity, *and* lower cost environmental improvement in the U.S. economy. They will encourage the environmental industry to deliver solutions that convey both economic and environmental advantage to their customers. They will also generate sustainability. The adoption of two types of policies and regulations is necessary, industry leaders say, to create regulatory incentives in the U.S. environmental management system:

Energy, and the Environmental Protection Agency. The document further states that "a principal finding of this interagency Strategic Framework is that the United States must maintain and strengthen its domestic environmental policy framework, encourage continued technology development and commercialization, and foster new public/private partnerships if it is to sustain a competitive position in the export of environmental technologies." In calling for "reducing barriers to technological innovation" by "shaping" "the regulatory regime which establishes and defines the environmental market," the document also says that "from a competitive perspective, innovation is one—and perhaps the—core source of competitive advantage both for individual firms and national industries."

Removing barriers and establishing market incentives will encourage the environmental industry and other suppliers of environmentally positive products and services to develop innovative solutions and introduce them to the marketplace.

- Two major market-enhancing regulatory reform strategies: *performance-based regulations* and *information-based requirements*.

- The *removal of regulatory and administrative barriers* to technology development and use.

Leaders suggest that government action needs to maintain a *steady* regulatory demand for environmental management while strengthening markets for environmental technologies that both generate economic wealth *and* improve the environment. Removing barriers and establishing market incentives will encourage the environmental industry and other suppliers of environmentally positive products and services to develop innovative solutions and introduce them to the marketplace. At least three new characteristics of environmental regulations are essential to this goal:

- ***Management for overall environmental results.*** Today's regulations are single media and source specific. This approach puts each source and residual on a distinct compliance schedule, fragmenting and compartmentalizing the management of each environmental decision. If Congress and the regulators shift to an approach based on overall environmental results (e.g., *total* pollution or risk per unit of output), they will encourage facility managers to improve their decisions. Managers will examine and manage environmental outcomes to optimize *overall* efficiency and costs, and they will integrate environmental decisions with their core business decisions. Companies will have greater control over their operations, and they and their suppliers will develop enabling technologies needed to meet economic and environmental goals.

- ***Increased flexibility.*** Regulatory flexibility is a pillar of advanced governmental environmental management strategies because it focuses regulatory effort on *results*—performance, by some measure—rather than on the *means* of achieving results. Flexible regulatory strategies specify the required results and allow companies to choose *how* to comply. Regulators are freed to *monitor results* through auditing systems, rather than specifying *how* companies will meet requirements and *monitoring the compliance process.*

- ***Increased predictability.*** The present system for drafting and promulgating new regulations presents great uncertainty about the timing, specific goals, and longevity of requirements. Al-

though EPA publishes an annual "regulatory agenda," innovators and regulated parties cannot be sure about what future *level of environmental improvement* they will need to attain, *when* they will need to comply, and *how long* the requirements will remain in place before revision.

In the new approach, companies would have the time to invest in innovation and could better measure the potential risks and rewards associated with these investments *if* key information is known far enough in advance: (1) the performance target, (2) the dates when the rule will be promulgated and compliance will be required, and (3) the duration of the market before the future rule will be revised. Most technology experts have suggested that at least 5 years and more likely 7 to 10 years advance notice is necessary for future regulations to stimulate innovation. EPA employed this approach in the ban on chlorinated fluorocarbons (CFCs), and the market was able to respond on a timely basis with improved chemicals. The allure of this approach, which has been tried only occasionally by EPA and state regulators, is so great for companies that each initiative and pilot program has been oversubscribed even though little if any relief has been offered relative to procedural or source-specific regulatory requirements. Most initiatives, in fact, have been open only to companies that commit to environmental gains that "go beyond" mandates.

3.2.2 Two Major Market-Enhancing Regulatory Reform Strategies: Performance-Based Regulations and Information-Based Requirements

The core of industry leaders' and their customers' proposals is two major regulatory reform strategies that convey major increases in flexibility, predictability, and the ability to manage for overall environmental results. These often can be used in lieu of technology-based regulations. Both help establish a framework for continuous environmental improvement and both are market enhancing. They are *performance-based regulations* and *information-based requirements*.

Performance-based regulations. Performance-based rules specify regulatory objectives but do not require the use of a specific technology. The objectives may address individual sources or entire facilities that emit a single type of pollution, and they are most effective when based on a total measure of all pollution associated with a source or group of sources. Regulatory approaches that are truly performance based have been tried,

The core of industry leaders' and their customers' proposals is two major regulatory reform strategies that convey major increases in flexibility, predictability, and the ability to manage for overall environmental results.

particularly under the Clean Air Act, but only for individual sources or groups of individual sources of one pollutant or a family of pollutants (e.g., the cap on acid rain precursors and tradable permits under the cap, "bubbles" which allow several individual sources of the same air pollutant to *collectively* achieve the requirement, even though some *individual* sources fall short). Each facility must meet the requirements (except when bubbling or its analogues are used) and must have flexibility in choosing the means for doing so. To be most effective in triggering the search for better technological solutions, performance-based rules will need to be based on a target for improvement that is established well in advance of, and separate from, the determination that a technology exists to meet the rule. In this way, sufficient time and incentive will be present to encourage innovation.

Regulatory strategies that harness market forces are an important technique for implementing performance-based regulations.

Regulatory strategies that harness market forces are an important technique for implementing performance-based regulations. Such strategies usually involve two steps: (1) comprehensive, or multimedia, requirements that apply to a category of sources, and (2) a market that allows source managers to seek economically optimal means to collectively reach the allowable limit. These strategies create incentives for continuing innovation, because the market allows companies to recapture the costs of innovation and deployment and to manage risks collectively, and because individual failures can be absorbed. These strategies also stimulate environmental excellence, because companies have incentives to use advanced technologies to surpass minimum requirements.

Several examples of such incentive-based regulations exist. Perhaps the most widely known addresses the airborne emissions of sulfur by allocating the total permissible emissions among all sources (via permits) and establishing a market for trading pollution rights. Some critics, however, dislike the idea of trading "rights to pollute." Another type of incentive-based regulation uses pollution fees or taxes. Few examples of this type exist, however, primarily because of widespread resistance to new government charges. In these strategies, sufficient lead time before requirements are set and implementation begins is needed to allow for development of innovative solutions.

Information-based requirements. Information-based requirements are exemplified by requirements for companies to collect and publish data about their use and release of toxic chemicals. No limits are placed on releases as part of these disclosure requirements. These requirements work when companies and other stakeholders make intelligent use of the information made available to reduce environmental hazards. For ex-

ample, better information enables companies to gain control of inputs to production and production processes. Several information-based programs have established that this approach can be effective. Many companies have applauded the Toxics Release Inventory (TRI), through which they and their suppliers have gained greater control of their manufacturing processes. The public, too, has spoken strongly in favor of the TRI because it has facilitated consumer decisions and helped communities work with local companies to reduce environmental problems while preserving jobs. EPA would evolve, in this area, toward an auditor role, rather than its present regulatory and enforcement role.

Better information enables companies to gain control of inputs to production and production processes.

3.2.3 Strategies to Remove Regulatory and Administrative Barriers to Technology Development and Use

Reforms are also critical in the permitting and compliance policies through which regulations are implemented, industry leaders say. In 1991, an EPA advisory committee published the first and most complete examination of the regulatory process barriers to technology development and commercialization.[53] Several independent works since have enumerated these same types of barriers and expanded the range of potential solutions.[54] These efforts suggested dozens of specific permitting and compliance policy changes that could stimulate technology innovation, in addition to identifying underlying regulatory process reforms that are needed to encourage and reward efforts to develop innovative technological solutions. The reason for so much focus on these policies is that issuance and enforcement of permits *is* the administrative mechanism for implementing regulations. Permits apply regulations to individual sources of pollution, and compliance policies persuade violators to take corrective actions. The most widely advocated changes include:

- improved permitting and compliance processes that reward enhanced performance gained from the use of innovative solutions,
- revitalization of waiver authorities and creation of "soft landing" policies,

[53] Technology Innovation and Economics Committee, *Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation*, 1991, *op. cit.*

[54] Office of Technology Assessment, *op. cit.*; the White House, *Working Papers of the White House Conference on Environmental Technology*, Washington, DC, December 1994; Esty and Chertow, *op. cit.*; Environmental Law Institute, *op. cit.*

- improved permitting processes that aid R&D and commercial introduction, and

- informational support for permit writers and compliance staffs, and use of independent audits.

Improved permitting and compliance processes that reward enhanced performance gained from the use of innovative solutions. Permitting and compliance systems could reward firms that seek enhanced environmental and economic performance by deploying advanced technologies. Regulators can generate real incentives for firms with sustained enhanced performance (who document that performance through independent audits) by such practices as reducing compliance oversight, extending the life of permits, and granting conditional exemption from permit renewal requirements. These changes would lower the transaction costs of environmental regulation in dollars and time, a significant incentive.

Of importance, regulators can also generate efficiencies for regulated firms by consolidating permits (through such techniques as bubbling and netting, which can view several sources as one) and by using multimedia and facilitywide permits (as tried in New Jersey and Massachusetts). If firms can apply for permits for all pollution sources at a facility together and simultaneously—or for one comprehensive permit—they will be encouraged to seek solutions that enhance economic and environmental performance.

It is also important for permitting and enforcement activities to be coordinated. This additional step is needed before firms can fully incorporate factors used in both environmental and economic decisions, improving their internal decision-making processes. Making systematic use of this approach (beyond trials in an enforcement context under an EPA 1996 policy) could create incentives to use pollution-preventing and other advanced techniques.

Some allowance of failure is necessary in sound compliance policy because innovative solutions may be less certain to produce compliance in their first applications.

Revitalization of waiver authorities and creation of "soft landing" policies. Some allowance of failure is necessary in sound compliance policy because innovative solutions may be less certain to produce compliance in their first applications. Two complementary policies are critically needed:

- ***Short-term compliance waivers.*** Short-term waivers of the need to comply were originally recognized in the federal clean air and water laws as a tool for encouraging *better* future compliance through the use of innovative solutions. These statutory waiver

authorities have expired. DOC evaluation of the waiver authority under the Clean Air Act revealed that it was ineffective: Few waivers were granted, 90% of applications were rejected, and the process took too long and was too costly.[55] Renewal and broader use of these waiver authorities is needed, but only if waiver processes offer a timely response to applicants and are linked to compliance accommodations.

- ***"Soft landing" policy.*** Failure to comply, by however minimal a margin, triggers enforcement action that usually results in penalties, orders to remove the failed technology, and replacement of the failed technology with one that is tried and true. Thus, under present policy, firms that try new technologies are at very significant risk. A "soft landing" policy is needed to reverse this scenario if good faith efforts have been made but fall minimally short of compliance requirements. Penalties should then be minimized or eliminated, additional time should be allowed to achieve compliance, and market mechanisms (e.g., pollution right trades) should be used on at least an interim basis to allow the experimenting firm to reach compliance.

Improved permitting processes that aid R&D and commercial introduction. A variety of improved permitting processes could be valuable, including those that aid the development, testing, and demonstration of innovative technologies for environmental purposes; accelerate permit applications in which innovative solutions will be used for compliance; and encourage comprehensive approaches that offer multimedia environmental gains and increases in efficiency and productivity.

First, permit applications that involve innovative technologies must receive high, not low, priority (i.e., applications for R&D and testing, and for early commercial uses). Today, these applications typically receive low priority; they move more slowly and take longer to process than those involving better established technologies. The most skilled technical and permitting staff must perform the reviews, and innovative technologies often involve greater risks, both to the permitting officials and to the company that intends to use them. Interstate coordination is needed, as well, to facilitate use of innovative technologies throughout the U.S. market (as is being experimented with in the work of the Interstate Technology and Regulatory Cooperation Work Group).

[55] Department of Commerce, Experimental Technology Incentives Program Policy Research Series, volume 3, *Incentives for Technological Innovation in Air Pollution Reduction*, January 1980.

Second, permitting processes need to be conducted (1) in a multimedia and facilitywide fashion and (2) in a coordinated manner that involves all regulatory authorities with an oversight function (across the levels of government and across jurisdictions). This is the necessary analogue to regulations that manage for overall results. Multimedia, facilitywide permit processes can be initiated with or without more sweeping regulatory changes, a step New Jersey and other states have attempted within existing legal structures. State and local regulatory authorities have long coordinated permitting actions across air quality control regions and river basins to ensure good results. Even with relatively narrow changes, multimedia and facilitywide permitting could begin to overcome the compartmentalization of environmental requirements and encourage integrated environmental management at regulated facilities, as well as integrated management of economic and environmental outcomes.

A variety of processes, including improved permit processes, could shorten the time and reduce the cost of introducing advanced solutions to the marketplace.

A variety of processes, including improved permit processes, could shorten the time and reduce the cost of introducing advanced solutions to the marketplace. For example, an effective multimedia process for obtaining regulatory approval to test new technologies is needed. Such processes are either ineffective or entirely absent from the major environmental statutes.

Informational support for permitting and compliance staffs, and use of independent audits. If permit and compliance staffs are to work closely with regulated firms developing or applying to use advanced solutions, they will need technical assistance and informational support to expedite their consideration. This help will allow them to maintain the confidence of the public and their superiors that their oversight is adequate. Because greater flexibility for regulated firms is associated with greater risk of noncompliance, these permit and compliance staffs must be able to assure the public that environmental gains will be achieved by advanced technologies. Technical assistance and informational support are keys to maintaining healthy relationships between regulators and regulated parties, on the one hand, and regulators and the public, on the other. Verification of technology performance and cost of performance can help meet this need. California's verification/certification program, along with EPA's, are beginning to fill this void, but have not yet satisfied all regulators, businesses, and other interested groups. The use of third-party audits may be a way of extending mutual confidence when more latitude is granted to regulated firms. The third-party audit approach is in use in Europe and experimentally in the United States. The ISO 14000 process embraces and makes use of this idea.

3.2.4 Reform of Governments' Own Environmental Management Activities

Government entities are major actors in two parts of the environmental market: as customers for environmental cleanup products and services, and as owners (and often operators) of environmental infrastructure. Important opportunities exist for improving governments' roles in both of these environmental markets.

Improving the Government Market for Environmental Cleanup

In addition to all of the problems that beset the environmental market as a whole, the government market has unique difficulties that make it an even more difficult one in which to succeed. Despite many reforms government has under way, industry leaders feel that the government market will remain a very difficult one until reforms are substantially completed. They also believe that private-sector investment in new technologies for this market will lag behind the need. Industry leaders and government advisory groups have observed that the contractors responsible for management of most government sites (those of the Department of Energy [DOE] and other agencies) have little incentive in the reward structure in their contracts to bring environmental problems at these sites to closure.[56] They have been rewarded for constant and reliable stewardship, rather than for using innovative technologies that accelerate cleanup and lower its cost.

In the DOE environmental management market and among the DOE-sponsored, commercially available technologies that have been used (or "implemented") more than once, as many multiple uses have been documented for non-DOE use as for DOE use. This suggests that the DOE market, one of the largest government markets, is more difficult to *enter* than private-sector markets for the same technologies.

Many in the environmental industry and many of its observers say that numerous opportunities exist for improving the government cleanup market. DOE is making attempts to make its captive market more attractive to the companies that provide products and services. A broad new DOE initiative to address the most important cleanup problems over the next 10 years is redistributing financial risks in ways that encourage site cleanup to be completed faster and at lower cost.[57] Specific incentives in this initiative include (1) use of performance-based procurement to allow cleanup contractors greater latitude in choosing which technical solu-

Despite many reforms government has under way, industry leaders feel that the government market will remain a very difficult one until reforms are substantially completed.

[56] Environmental Management Advisory Board, 1996, *op. cit.*

[57] Department of Energy, *2006 Plan*, 1997.

tions to deploy, with incentives to encourage them to choose innovative solutions that are advantageous; (2) privatization of the procurement process to create direct incentives for speedy cleanup action (i.e., hiring contractors to manage complex cleanup jobs who then contract for the many products and services needed to complete the job); and (3) eased procurement processes. Within the Department of Defense (DOD) market (and in a number of market segments outside the direct DOD market), many observers have noted the need to reform the MILSPEC system, which is seen as locking in technologies and inhibiting the use of innovative solutions.

Improving the U.S. Market for Environmental Infrastructure

The markets for wastewater treatment, potable water supply, and solid waste management (including recycling) remain largely a function of government agencies in the United States. These environmental infrastructure industries generally lack a tradition of efficiency and optimization. Subject as they have been to local or regional government budget strictures and accounting practices, these utilities have not had substantial resources for R&D and have had capital budgets too limited to take advantage of technological opportunities. Political constituencies affected by technological or institutional change (e.g., finance, support contractors, labor) have been resistant to change. Privatization of solid waste management services has been the solution of choice for many governments, and this trend is well advanced nationally for solid waste, recycling, and hazardous waste.

Many observers expect that this trend will extend to wastewater treatment and potable water supply.

Many observers expect that this trend will extend to wastewater treatment and potable water supply. Three factors sit at the heart of this possibility: technology, economies of scale, and finance:

- ***Technology.*** U.S. environmental infrastructure markets have been slow adopters of new "hard" and "soft" technologies compared to all other segments of the environmental marketplace and even more so to fast-growing technology markets such as semiconductors. Federal sponsorship of R&D has been at extremely low levels for wastewater treatment and potable water supply for more than a decade, making technology opportunities for these two environmental segments the least well researched of all. Governments and the private sector overseas have larger efforts underway to develop all types of environmental infrastructure technologies. The formation of the Civil Engineering Research Foundation starts to band together the customers of water-related technologies for R&D, but this effort is small.

- ***Economies of scale.*** Internationally, economies of scale have been an important factor in the establishment of competitive edge. The largest and most efficient firms in the world have emerged from the privatization of the wastewater and potable water supply industries in Europe, particularly France and Great Britain. These firms originate and adopt advanced technologies, both management systems and hardware, are increasingly vertically integrated, and have financial advantages due to their size, stable home markets, and position in the private sector. These advantages give them broader access to the financial markets. As noted earlier, these European firms have been ranked as the world leaders.

- ***Finance.*** The future of public-sector environmental infrastructure companies is linked to the financial strength of local and regional governments, to public-sector financial and accounting structure, and to customers' and voters' willingness to pay for technologies and other capital improvements that convey cost advantages and better service over the long term. In the case of the solid waste industry, lower cost services provided by the private sector won out over most traditional public agencies. In other infrastructure areas, many communities—including some of the largest and many of the smallest—are experiencing operational difficulties that mirror their financial position. In New York City, for example, decaying infrastructure has failed, causing a number of major water main breaks. Separately, small cities and towns decry "unfunded mandates" and resist compliance with environmental regulations for wastewater treatment systems and potable water supplies because they cannot afford the cost of improvements.

The future of public-sector environmental infrastructure companies is linked to the financial strength of local and regional governments, to public-sector financial and accounting structure, and to customers' and voters' willingness to pay for technologies that convey cost advantages and better service over the long term.

3.2.5 Other Nonregulatory Steps to Improve the Competitiveness of the Environmental Industry

A wide variety of other nonregulatory steps should be taken to improve the competitiveness of the environmental industry and with it, the competitiveness of customers of the industry. Among them are using government procurement processes to create a market pull, and education and training to ensure an environmentally skilled work force.

Using Government Procurement Processes to Create a Market Pull.

As noted by Banks and Heaton,[58] "Commercialization of new technologies can be speeded by deliberately creating a market." Many products

[58] Banks and Heaton, *op. cit.*, page 49.

require significant demand before their manufacture can be profitable (e.g., energy-efficient refrigerators) or their production can be scaled up. Even if a technology product is developmentally advanced, the investment required for market introduction may be too large to make without an assured initial demand. Government procurement processes, purchase guarantees, and persuasion can build this customer demand for economically and environmentally advantageous products and services.

Human Resources: Ensuring an Environmentally Skilled Work Force

A skilled and motivated work force is imperative, especially for the environmental industry, in which products and services are becoming increasingly advanced in technical terms. It is equally important for workers in the industry's customer companies to be environmentally literate.

Opportunities exist in the United States to strengthen cooperation between governments at all levels and the private sector to help grow a large, skilled, motivated work force that is environmentally literate.

The foundation of a skilled work force is education. Young students need to stay in school, achieve basic educational requirements, and gain specialized training and advanced skills needed for many jobs in the environmental industry. Integrating environmental literacy into education is a primary governmental role. Building environmental knowledge into science, engineering, and business curricula is vital for the future of the U.S. environmental industry and environmental quality in the United States.

Opportunities exist in the United States to strengthen cooperation between governments at all levels and the private sector to help grow a large, skilled, motivated work force that is environmentally literate. These workers protect the environment better, and this perspective makes them better customers for advanced environmental products and services. Workers who are more involved in production decisions can be more dedicated, produce at higher levels of output, and be less wasteful of time and materials, as shown by Dr. V. Edward Deming, originator of total quality management (TQM). The principle of systematic and continuous improvement has been embodied in the practice of strategic environmental management. ISO 14000 and other SEM methods are becoming widely used in the United States and internationally as management tools that build environmental as well as other quality objectives into day-to-day and strategic business decisions. Government at all levels can take steps to encourage these corporate behaviors by helping the United States integrate environmental study into general and professional education.

3.2.6 Nonregulatory Roles of Government to Facilitate Private-Sector Innovation and Diffusion

Industry leaders emphasize the need for greater collaboration and cooperation between government and industry to facilitate the innovation process *without* large increases in government R&D funding and *without* unreasonable government interference in the marketplace. Traditional discussions of governmental roles in R&D have focused on the *amount* of R&D dollars for technology and the *distribution* of these dollars among competing technical areas.

But the technology innovation process includes the processes of R&D, demonstration, and commercialization (product and business development leading up to and including market entry). For commercialization to occur, a technology-based product must be ready to compete in the marketplace. It must, at a minimum, have *demonstrated cost, performance, and/or service advantages* over available technologies; be *commercially available* (i.e., one or more vendors offer products and services based on the technology); and have *overcome nontechnical barriers* (e.g., regulatory, public acceptance, business planning and development, financial hurdles) that impede commercialization and use.

Industry leaders emphasize two roles of government that require more attention and resources during the technology innovation process:

- ***Facilitation of technology efforts sponsored by the private sector.*** Industry leaders note that in our market-based economy, *only* private companies can commercialize the technologies that the nation needs to remain competitive. Government facilitation is needed to help companies fill the marketplace "toolbox" with commercial, deployable solutions to economic and environmental problems. Companies that are commercializing a product or service that responds to a need in the marketplace must have an organization to gain market access, raise necessary capital for product development, and build up a capacity to deliver. Government cannot and should not preempt corporate business development decisions, marketplace determination of "winners and losers," and the site-specific procurement process in the government market.

- ***Aiding diffusion of new environmentally beneficial technologies.*** In addition to government R&D and facilitation, stronger informational programs are needed to stimulate the use of innovative environmentally beneficial technologies in the United States. The

In addition to government R&D and facilitation, stronger informational programs are needed to stimulate the use of innovative environmentally beneficial technologies in the United States.

government can use several strategies to help the environmental industry, the financial community, environmental regulators, and the public make informed decisions about innovative technologies under development. These strategies take advantage of government skills, facilities, tools, and information to make the processes of innovation and diffusion work more efficiently in the market for environmentally beneficial technologies.

A broad expansion of catalytic, nonregulatory government activities is needed to facilitate technology innovation sponsored by the private sector.

Catalyze Technology Innovation Sponsored by the Private Sector

A broad expansion of *catalytic*, *nonregulatory* government activities is needed to facilitate technology innovation sponsored by the private sector. These activities improve the efficiency of the innovation process by reducing time to market and stretching private-sector R&D investments. Support is most important for five types of government facilitation activities:

Verification of technology performance. As discussed in Chapter 2, performance verification can significantly accelerate both the commercialization of new environmentally beneficial technologies and their acceptance by regulators, potential customers, the financial community, and the general public. Vendor claims for technology performance, no matter how valid, are rarely accepted by any of these stakeholders. Credible performance and cost-of-performance data can facilitate and accelerate the permitting and compliance decisions through which use is approved. Verification can supply the marketplace with universally recognized data. At the same time, some industry leaders note that a verification system could create a new hurdle to market entry, increasing costs and time to market, if the system is not well designed.

Most industry leaders say that federal and state agencies need to work quickly with the industry and its customers to institute a voluntary, national system for verifying performance. To be market enhancing, this process must have (1) the ability to verify the performance of *any* kind of environmentally beneficial technology, (2) the capability to produce comparable performance data about *all* technologies that accomplish the same environmental objective even if they are based on fundamentally different operating principles, (3) reasonable cost, (4) adequate capacity to meet demand in a timely fashion, and (5) universal acceptance by federal and state regulators, and even if possible, international bodies.

Industry leaders commented that the work of the departments of Energy and Defense, in conjunction with the 25-state Interstate Technology and Regulatory Cooperation Work Group (ITRC) and EPA, has been a good

first step toward building reciprocal recognition of verified performance data among state regulators. This work, along with the State of California's certification/verification program and EPA's Environmental Technology Verification pilots, has begun to build a national verification process for technology performance data. The ITRC's and California's emphasis on reciprocity is critical to ensuring the value of verified data because regulatory personnel from independent state and local environmental authorities will need to accept these data as establishing application-specific technology performance. Without regulator acceptance, verified data will not facilitate permitting and compliance decisions. The interstate effort also may lead to development of an overarching guideline that establishes requirements for performance data generated during tests.

Business assistance and financial advice. Many technology developers, trained as scientists or engineers, do not possess skills needed to successfully develop and commercialize environmentally beneficial technologies. They may lack skill in business planning, market research, risk analysis, and financial planning, as well as knowledge about environmental regulatory processes that affect innovation and use. Assistance of this type provided with government support, such as the Dawnbreaker[59] service, has increased private-sector investment in young environmental companies, helped companies target their new technology products for market entry, and identified ways to strengthen business planning and operating processes in dozens of young U.S. technology companies. Without this type of assistance, many of these companies would have failed *before* their products could enter the market and compete, and many new technology-based products and services would have been lost.

Business assistance and financial advice have increased private-sector investment in young environmental companies, helped companies target their new technology products for market entry, and identified ways to strengthen business planning and operating processes in dozens of young U.S. technology companies.

Planning and analytic tools. These tools help companies integrate environmental and economic decisions, enabling them to target the best opportunities for technology innovation efforts and enriching the decision-making process for technology choice. Life-cycle accounting is one of the best known of these advanced tools. Demand for advanced technologies will increase with widespread use of more sophisticated accounting methodologies and other analytic tools that integrate environmental and productivity decisions. Business leaders argue that government must be involved in the development of these tools.

R&D partnerships. Government has helped companies form industrial partnerships for the development of precommercial technologies, begin-

[59] "Dawnbreaker" is a registered trademark of Dawnbreaker, Inc., Rochester, NY.

ning with the 1984 amendments to the Sherman Anti-Trust Act. These amendments permit companies to collaborate on and to cofund R&D on high-risk, precompetitive technologies that, if successful, the companies will separately exploit in new products. EPA's Design for the Environment program has helped companies form cooperative arrangements for the development of precommercial technologies that appear to have potential for similar advantages. In the case of the DOC's Advanced Technology Program, the government has also augmented private-sector funding for R&D on precommercial technologies that were selected through a competitive process.

The Federal Technology Transfer Act[60] established policies that allow government agencies to enter into "cooperative research and development agreements," or CRADAs. These agreements provide a vehicle for cooperation between a government agency and a company during the technology innovation process. Companies can gain access to unique government expertise and facilities that can be instrumental during R&D and product development. Thus, CRADAs provide a mechanism for technology-specific partnering that complements the process of industrywide technology partnerships.

Testing venues. Government agencies can also provide access to venues at which innovative technologies can be tested. DOD and DOE have been most prominent in allowing outside companies to test technologies at their sites, but this permission has usually been restricted to technologies with site-specific (or more broadly, mission-specific) applicability. Broader access to federal sites and facilities is needed to allow companies to test environmental technologies that have application in nongovernment markets.

Industry leaders and their customers say that stronger government information and technology diffusion programs are essential to environmental protection and to healthy environmental markets.

Strengthen Informational and Other Diffusion Programs that Enhance the U.S. Market for Environmental Technologies

Industry leaders and their customers say that *stronger* government information and other technology diffusion programs are essential to environmental protection and to healthy environmental markets. They emphasize that these programs must be *separate* from regulatory programs.[61] As part

[60] Federal Technology Transfer Act of 1986 (P.L. 99-502). Later amendments to this law, including the National Competitiveness Technology Transfer Act of 1989 (P.L. 101-510), expanded the coverage of P.L. 99-502.

[61] The term "diffusion" refers to the "spread and adaptation of a technical idea following its first successful commercial use." Technology Innovation and Economics Committee, *Improving Technology Diffusion for Environmental Protection, op. cit.*, page iii–iv. See also Office of Technology Assessment, *op. cit.*; Banks and Heaton, *op. cit.*

of a broad strategy to reform regulations and strengthen informational programs, environmental agencies need to make technology diffusion a major supporting mission.[62]

Regulators' need for better information was discussed earlier in this chapter. Many of the industry's customers share this need. After years of federal, state, and nonprofit diffusion programs, much is now known about how to do it and whom to target. The largest and most technically sophisticated firms invest the most in technology innovation and are the most rapid adopters of technological advances.[63] These leaders require little help. Smaller and mid-sized firms, on the other hand, are often "willing to change, but need technical assistance" to take advantage of the opportunities for economic and environmental progress presented by innovative technologies.[64]

Business leaders say that more government resources are needed to strengthen informational systems that help companies adopt advanced technologies. Several types of information and diffusion efforts are needed. Among the most important are information outreach and technical assistance.

As noted by Banks and Heaton,[65] "Environmental improvement presents highly technical issues; little can be accomplished absent information about the nature and extent of the problems and the range of solutions available. The information base on which environmental decisions are made is in need of major improvement, especially at the level of individual firms." Two broadly different approaches can be taken: hands-on technical assistance and electronic databases.

Technical assistance. Hands-on technical assistance provided by *trusted* advisors is *the key* to widespread adoption of improved technological solutions by small to medium-sized firms (less than $100 million in market capitalization). This point is seen in Florida's data, and it is the lesson of the Department of Agriculture's Agricultural Extension Service. DOC is applying the lesson with the Manufacturing Extension Centers, and EPA uses it in the Design for the Environment program. Several states and other service organizations (both for-profit and nonprofit) also

Hands-on technical assistance provided by trusted advisors is the key to widespread adoption of improved technological solutions by small to medium-sized firms (less than $100 million in market capitalization).

[62] *Ibid.*

[63] For example, Florida, *op. cit.*

[64] Banks and Heaton, *op. cit.*, page 47.

[65] Banks and Heaton, *op. cit.*, page 46. See also Technology Innovation and Economics Committee, *Improving Technology Diffusion for Environmental Protection, op. cit.*

provide independent technology advice. Such services are important to firms in the environmental industry, because they provide an independent and credible source of information about these firms' products and services, and because they help customers improve their decision-making processes to the point that they can see the benefits of improved technologies.

Databases. The experience of DOC's Manufacturing Extension Partnership, the results of Florida's research, and the comments of other technology transfer professionals support the proposition that large databases are most valuable to the largest, most innovative, and most technically competent firms. These firms are most apt to seek, understand, and use the extensive and detailed technological information available electronically. Smaller firms usually rely on the advice of technical advisors, vendors, and other outside sources of technological information because they are less able to make independent technical decisions.

Advanced management tools. As discussed earlier, government support (in both regulatory and diffusion programs) to efforts to expand the use of advanced management methods is needed. Florida's work[66] indicates that the use of advanced management tools (such as ISO 14000, TQM, and life-cycle accounting) facilitates improved decision making in larger companies. He showed that "green"-designed plants adopted "a related bundle of advanced manufacturing practices including total quality management, quality-oriented product design, just-in-time inventory control, a flat organizational hierarchy (e.g., a low ratio of managers to production workers), high levels of employment security, cooperative supplier relations, and electronic data interchange as well as green design." Without technical assistance, use of these methods is not likely to spread rapidly among smaller firms.

Information-based voluntary programs. One major contribution of information-based environmental management systems (e.g., the Toxics Release Inventory, "green" labeling) is that they are self-illuminating for companies. In other words, companies that participate can learn a great deal about their internal practices, creating opportunities to improve internal controls and to identify alternatives to business as usual. Another contribution is borne in the sharing of some information with outside constituencies. Informed customers and informed publics often reward companies that employ advanced manufacturing techniques and produce "green" products, creating market advantages. Industry leaders say that greater

[66] Florida, *op. cit.*, page 101.

use of these market-enhancing programs would be advantageous and that government, as well as the private sector, should expand them.

Other Steps for Expanding the Impact of Government R&D Related to Environmentally Beneficial Technologies

Industry leaders propose several steps to improve the commercial development of environmentally beneficial technologies—a goal essential to the attainment of broader public policy objectives for the environment. If even a small increase in the commercialization rate of these technologies were to occur, it would have a greater impact than a significant increase in government R&D investment.

At least four major approaches are supported by industry leaders as a means of increasing the overall commercialization rate and increasing taxpayer return on investment (measured by economic and environmental gain) on government support for environmental R&D:

Shift government R&D funds to support activities that facilitate private-sector technology development efforts. Industry leaders suggest that an increased portion of government environmental R&D resources be used to *facilitate* industry-supported technology innovation. This would include support for research partnerships with industry aimed at developing precommercial technologies, as discussed earlier in this section. A small increase in the amount of government facilitation may have a large leveraging effect on the success rate of the larger pool of private-sector R&D resources.

Increase support for research on technologies that are both economically and environmentally enhancing. Those technologies that are both economically and environmentally enhancing can have the greatest positive impact on U.S. economic competitiveness and on the achievement of U.S. environmental goals. Industry leaders urge that government R&D should emphasize support of such technologies. Banks and Heaton suggest that the government support should go to "critical technologies of generic applicability in areas where private R&D is not keeping pace with the national need."[67] They also suggest that "environmentally relevant R&D should become a designated sub-component of current R&D programs, especially those directed at industrial needs."

Balance government's decision-making factors to include business considerations, as well as technical and programmatic values. Investment decisions in government applied technology R&D programs are

[67] Banks and Heaton, *op. cit.*, page 48.

necessarily based first on programmatic and technical factors. However, environmental technologies ultimately serve programmatic interests only when they are successfully commercialized by the private sector. The potential for technologies to make a market impact, however, has not usually been a significant factor in funding decisions other than in such programs as the Advanced Technology Program. Also, few programs have included peer reviews in their process and, even if they do, have not included business expertise.

Industry leaders propose that government programs that fund environmentally related applied R&D make four modifications: (1) expand the factors used in the decision-making process to include prospects for commercialization, (2) make greater use of peer review panels that include the private sector, (3) increase the portion of their R&D performed in collaboration with the private sector, and (4) require private-sector co-funding as technologies mature during R&D.

Ensure timely transfer of government-controlled patents to the private sector. U.S. law clearly favors the transfer of government research to the private sector to encourage development of valuable new products and services. Industry leaders believe that these federal policies can be particularly effective in the area of environmental research and urge that special attention be given to several aspects of these policies in the case of environmental technologies:

- Claiming and securing patents on inventions originating in federally supported R&D.
- Developing plans to maximize use of intellectual property through an equitable and open transfer process.
- Maintaining readily accessible information concerning the nature and status of all intellectual property arising from federally supported environmental R&D.

3.3 Strategies for Government/Industry Cooperation to Increase Environmental-Related Exports

Industry leaders believe that U.S. environmental exports offer significant opportunities for environmental improvement and increased revenues over the next 2 decades. U.S. humanitarian and economic interests combine to create incentives for capturing market share in infrastructure development, as well as for competing more successfully in advanced environmental markets. The potential domestic economic benefits are

great. In 1997, exports supported an estimated 12.1 million jobs, up from 11.5 million in 1996.[68] A large majority of companies in the industry are, however, poorly positioned to win business because of a traditional domestic focus, because their small size and limited resources make exporting difficult, and because of intense trade competition worldwide.

Industry leaders believe that U.S. environmental exports offer significant opportunities for environmental improvement and increased revenues over the next 2 decades.

Fundamental to the future success of U.S. environmental industry exports will be a culture of strong public/private cooperation on managed trade policies and economic development. Industry leaders foresee the need for a full range of support provided by sponsoring agencies. Support should be strengthened in several areas including technical assistance and planning, capacity and demand building in less developed (but emerging) markets, export finance, export promotion and advocacy, direct support for U.S. environmental technology exports, and assistance to U.S. companies to close international deals.

Executives of environmental exporting companies assert that many foreign governments have been spending far more on the promotion of exports of their national companies, placing U.S. companies at a distinct disadvantage in the global market. Companies based in these countries benefit from financial incentives to prospective customers and fewer imposed restrictions on trade practices. Industry executives advocate greater coordination among government agencies that help U.S. companies export environmental products and services, while noting the need for environmental companies to work more closely together to provide turnkey solutions for environmental problems overseas. The U.S. response to the need for closer partnering between the government and the environmental industry was seen, by 1990, as an adjunct to the broader cross-sector trade issues already being addressed by the presidentially mandated interagency Trade Promotion Coordinating Committee (TPCC). Furthermore, both the executive branch and the Congress have taken a series of actions that establish the groundwork for concerted government/industry action on behalf of U.S. environmental exports.

Executive branch action on general trade policy over the past 10 years has included (1) important U.S. Trade Representative (USTR) negotiations on the General Agreement on Tariffs and Trade and the establishment of a World Trade Organization, (2) successful conclusion by the Department of State and USTR of the North American Free Trade Agreement and subsequent commitments to a Free Trade of the Americas Agreement by 2005, (3) significant progress by Department of the Treasury negotiations on the Helsinki Package, and (4) the 1992 Organization

[68] U.S. Trade Representative, Office of Economic Affairs.

One of the key issues that emerged is the need for a unified approach to the export market for environmental products and services.

for Economic Cooperation and Development (OECD) Arrangement on Guidelines for Officially Supported Export Credits.[69] The Clinton administration also has conducted a series of nationwide focus workshops with the industry and the public. One of the key issues that emerged is the need for a unified approach to the export market for environmental products and services.

Congressional actions have included, among other program authorizations, passage of the Export Enhancement Act of 1992[70] (EEA). EEA codified the Trade Promotion Coordinating Committee that was established by an executive order in 1990. TPCC is an interagency coordinating body composed of the departments of Commerce, State, Treasury, Agriculture, Energy, and Transportation, USTR, the Small Business Administration (SBA), the Agency for International Development (AID), the Overseas Private Investment Corporation (OPIC), the Export-Import Bank (ExIm Bank), and the Trade and Development Agency (TDA). In a separate action, the President issued an executive order to include the departments of Defense and Labor, EPA, the U.S. Information Agency, the National Economic Council, the National Security Council, and the Council of Economic Advisors as member agencies. A total of 19 federal departments and agencies now make up TPCC.

3.3.1 Formation of the Environmental Trade Working Group and the Environmental Trade Advisory Committee

The Export Enhancement Act of 1992 directed the Secretary of Commerce to establish an Environmental Trade Working Group (ETWG) to "address all issues of export promotion and export financing." This policy-level body serves as the coordinating body for the TPCC environmental export promotion agenda. A predecessor to ETWG that included DOC, EPA, and White House advisors published a policy paper in November 1993 entitled "Environmental Technologies Exports: Strategic Framework for U.S. Leadership."[71] In it, the advisors established four goals that have served as the outline for subsequent ETWG activities:

- Engage U.S. business in partnership with the U.S. government.
- Strengthen the technology development and commercialization abilities of the domestic environmental industry.

[69] Organization for Economic Cooperation and Development (92) 95, 1992.

[70] P.L. 102-429, Section 201.

[71] November 1993.

- Help U.S. businesses succeed in the most important markets today, while developing tomorrow's most valuable markets.

- Coordinate and better focus U.S. government export programs and resources.

In 1994, Congress passed the Jobs Through Trade Expansion Act.[72] This act mandated establishment of an industry advisory committee to be called the Environmental Technologies Trade Advisory Committee (ETTAC). The Secretary of Commerce, as chairperson of TPCC, established a 35-member committee on May 31, 1994, pursuant to the Federal Advisory Committee Act.[73] The activities of ETTAC are coordinated by DOC's Office of Environmental Technologies Exports in the International Trade Administration. Through ETTAC, a broad representation of private-sector companies has been brought into formal dialog with the U.S. government on environmental trade development and promotion.

The first ETTAC meeting was held in Washington, DC, on December 14, 1994, in conjunction with the White House Conference on Environmental Technology. The charter of ETTAC states the committee was established to provide "advice and guidance" to the U.S. government in the development and conduct of programs to expand U.S. exports of environmental goods and services. The committee was comprised of representatives from leading trade associations, large and small companies representing both manufacturing and services, and private-sector organizations involved in the promotion of environmental exports. On May 31, 1996, ETTAC was rechartered for a period of 2 years.

Through ETTAC, a broad representation of private-sector companies has been brought into formal dialog with the U.S. government on environmental trade development and promotion.

ETTAC adopted the following mission statement:

> **To advise and guide the policies and procedures of the U.S. Government through the TPCC in order to increase environmental exports in the interest of the U.S. environmental industry.**

ETTAC has developed recommendations through intensive dialog with U.S. federal agencies and trade and professional associations. These recommendations target some of the most critical issues that must be addressed to effect positive change in the competitiveness of the U.S.

[72] P.L. 103-392.

[73] 5 U.S.C. Appendix 2.

environmental industry in international markets. The recommendations are summarized below but are available in ETTAC's complete report from the Office of Environmental Technologies Exports. The numbered items are direct quotes from the committee's report.

3.3.2 ETTAC Recommendations

1. **Continue U.S. Government programs to assist environmental development and exports currently being implemented by the member agencies of the Environmental Trade Working Group of the TPCC.**

ETTAC believed that to further the export agenda, existing efforts should continue to receive support and budget without suffering cutbacks. ETTAC argued that the existing programs were fundamentally sound. However, ETTAC suggested that greater levels of coordination were needed to effectively execute the programs.

2. **Reallocate resources to enhance the effectiveness of key U.S. Government support programs that have proven to be of greatest value in assisting U.S. companies with environmental export initiatives.**

ETTAC recommended a broad look at the budgets and programs of key agencies and suggested an evaluation of the returns U.S. citizens receive from U.S. government expenditures. The detailed text of the subrecommendations focus substantially on issues and reform of "tied aid" (i.e., provision of development assistance linked to the recipient country's use of products or services from the donor nation).

ETTAC concluded that both export promotion and development assistance are important for long-term export market development and emphasized the importance of continuing to support the critical international programs of AID, TDA, EPA, ExIm Bank, and OPIC.

ETTAC concluded that both export promotion and development assistance are important for long-term export market development and emphasized the importance of continuing to support the critical international programs of AID, TDA, EPA, ExIm Bank, and OPIC. The institution-strengthening support provided by AID is critical to open markets. The technical assistance and training programs that can be offered by EPA and DOE help build buyers' capacity to make decisions based on sound scientific and technical criteria. The TDA program expands U.S. firms' ability to compete with firms from other OECD nations that support early data collection of commercially viable projects. In 1997, TDA directed 15% of its funds to environment-related projects. The U.S. ExIm Bank programs are critical for underwriting financial transactions, while OPIC's programs are important for insuring private investors against political and economic risks. ETTAC's report also provides a dynamic

model of how each of these, as well as other U.S. government programs, can work together more effectively to improve the international competitiveness of U.S. environmental companies.

3. Develop recommendations for congressional action on key statutes and code revisions that would eliminate disincentives for U.S. company participation in foreign markets.

ETTAC recommended

- instituting a set of important revisions to the U.S. tax code, and
- implementing a broad review and revision of U.S. antitrust law to enhance cooperation among companies.

Limitations Imposed by the U.S. Tax Code

Many foreign competitors enjoy tax incentives that create a "nonlevel playing field" that limits the competitiveness of U.S. companies in their overseas environmental technology and services markets. U.S. companies are being forced to compensate for their higher tax liabilities by either reducing aftertax income or by raising the price of the project bid. ETTAC offers specific guidance on what Congress should do to revise the tax code to improve U.S. competitiveness overseas by leveling the playing field.

Sherman Anti-Trust Provisions

The Sherman Anti-Trust Act prohibits U.S. companies from cooperating in the pricing of goods and services. This law was originally passed in the 1800s to counter efforts to fix prices and gain monopoly control of certain sectors. More recent policy deliberations have led U.S. decisionmakers to realize that collaboration in foreign markets can be beneficial to gain a competitive advantage for U.S. companies against foreign competition. On October 8, 1982, President Reagan signed into law the Export Trading Company Act of 1982.[74] This law was intended to increase U.S. exports of goods and services, primarily by removing two impediments: (1) restrictions on trade financing and (2) uncertainty about the application of U.S. antitrust laws to export trade.[75] ETTAC outlined a course of action to encourage greater sector participation in the advocacy of congressional action.

Many foreign competitors enjoy tax incentives that create a "nonlevel playing field" that limits the competitiveness of U.S. companies in their overseas environmental technology and services markets.

[74] P.L. 97-290.

[75] Department of Commerce, International Trade Administration, *The Export Trading Company Guidebook*, Washington, DC: U.S. Government Printing Office, August 1987.

ETTAC recommendations for advocacy actions by U.S. government agencies are not limited to the water segments of the environmental industry.

4. Increase U.S. Government advocacy for U.S. private-sector participation in major project initiatives in key emerging markets.

ETTAC outlined nine specific actions agencies could undertake to continue to support private-sector efforts. In developing these recommendations, ETTAC conducted an in-depth analysis of a single industry segment that is in great demand in the developing world: potable water systems (see Box 1). The privatization of potable water markets was seen as a good example of an emerging market opportunity that would lend itself well to public/private collaboration. ETTAC recommendations for advocacy actions by U.S. government agencies are not limited to the water segments of the environmental industry, however. Each segment can benefit from U.S. government efforts to provide institutional strengthening and capacity-building support through technology transfer, demonstration projects, regulatory development support, financing assistance, and development assistance.

5. Continue to consolidate and coordinate environmental trade development and promotion activities of all U.S. Government agencies under the Trade Promotion Coordinating Committee through the Environmental Trade Working Group.

ETTAC believes that the most effective way to accomplish this task would be to ensure that ETWG is given the opportunity to review and comment on the proposed budgets for individual agencies. This could be accomplished through the unified budget planning process initiated by the Clinton administration. Analysis and review could lead to design and implementation of more efficient programs, and avoidance of duplication.

6. Hold regular meetings between the Environmental Trade Working Group and the Environmental Technologies Trade Advisory Committee on matters of policy and budget development and allocation.

3.3.3 Dynamic Models for Intergovernmental Cooperation and Greater Industry Collaboration

Greater coordination among the public-sector agencies charted in ETTAC's dynamic model is only half the battle for a successful export agenda. The other half is for U.S. private-sector companies to overcome traditional domestic competitive orientations and to form a unified voice and achieve unified action for the environmental industry. The techniques to be used include such diverse activities as the following:

Box 1. Global Potable Water System Market

The potable water supply and wastewater treatment segments in emerging market economies represent an $85 billion annual market. To successfully compete for opportunities in the private management of municipal water and wastewater treatment systems, U.S.-based companies must counter a fast start by European-based competitors and poor market positioning. This positioning is not the result of a lag in technology, but rather a domestic market that is late to adopt privatization, has had a history of specialization in segments of the market, and has had statutory and cultural restrictions on cooperation.

The European water companies have historically had the benefit of government support for their export efforts. They have evolved into large, broadly capable companies that have led the effort to privatize markets in countries around the world. The global market for privately operated water supply and wastewater management systems is growing dramatically as successful projects are launched and as examples proliferate of privately operated water supply systems that offer improved quality and service, as well as financial success.

The structure and dynamics of the U.S. water supply and wastewater market can provide some insight into the relative costs associated with each of the above noted components of a total delivery system. Certain U.S. tax code disincentives have suppressed privatization in the domestic markets and have contributed to the United States' slow response to global privatization. (The Municipal Wastewater Facility Private Investment Act of 1993, S. 1681/H.R. 3539, was introduced to address these issues. It was never reported out of committee.) Furthermore, our companies' competitiveness is in part hindered by aggressive government support provided by other countries.

Industry leaders say that TPCC agencies need to provide extensive on-the-ground support for tender offers by the U.S. consortia in key privatization bids. About 100 U.S. Commercial Service officers have undergone a 1-week training program in Washington, DC, in support of the environmental export agenda. This type of special training could be expanded and supplemented specifically for facilitating the specialized needs of the water supply and wastewater treatment sector.

ETTAC recommended more advanced training and placement of specialists knowledgeable about privatization issues in the embassies of the larger emerging market countries and other select countries. The primary responsibility of these specialists would be to support upcoming privatization tenders in the water market.

- Formation of export trading companies, some of which may be organized on segment-specific or geography-specific lines.
- More effective use of existing trade and professional associations for promoting exports (e.g., the U.S. Environmental Export Council, the Water Environment Federation, the Water and Wastewater Equipment Manufacturers Association, the Environmental Industry Coalition).
- Federal and state coordination of marketing efforts during government-sponsored trade missions.
- More effective teaming on concession bids.
- More innovative and collaborative approaches to combining products and services into packages for submittal to investors for structured project finance deals.

Greater coordination among the public-sector agencies charted in ETTAC's dynamic model is only half the battle for a successful export agenda.

3.3.4 Coordination With Financing Institutions

Integration of the banking and financial communities into a newly vitalized and integrated public-sector program will require effective communication. Public- and private-sector representatives must be able to demonstrate clearly how the financial industry's criteria for return on investment can be satisfied in connection with delivery of products and services previously excluded from the market formula. This remains a tall order. However, with economic and environmental policy becoming more tightly fused, integration with the financial community will grow increasingly crucial.

3.4 Financing for a Competitive Environmental Industry

Industry leaders suggest that financial resources will become more available to their companies when factors that contribute to financial risks become more manageable. This section describes the reasons industry believes that specific actions discussed earlier in this study could help to improve management of risks.

In general, the most potent approach to bringing needed investment and growth capital to the environmental industry, as well as financing for its projects, is to stabilize and stimulate demand for environmental products and services by rewarding continuous environmental improvement. To do this, regulators must increase incentives for using resource-efficient

technologies. Incentive-based rules stimulate ongoing purchases of environmental products and services, while the demand created by "command and control" rules declines when compliance is achieved. Incentives to go beyond compliance would provide more opportunities for the industry to profit and thus attract capital. Industry leaders call for implementation in the near term of several specific steps that could help the industry manage risk and could encourage the financial community to make capital investments in the industry.

3.4.1 Performance-Based Approaches to Environmental Regulation

As discussed earlier, investment in the development and use of innovative solutions is dependent on the recasting of regulations and regulatory processes through the use of performance-oriented and information-based incentive mechanisms. Such mechanisms are important because they can not only drive compliance, they can be a positive stimulus for environmental excellence. Increased use of independent, third-party auditing systems to assure compliance would place EPA and state regulatory agencies in a role that is similar to that of the Securities Exchange Commission (SEC) in supervising financial markets. Increased use of regulatory and nonregulatory methods to inform environmental decisions and increase the efficiency of market activities would make risks more manageable.

The most potent approach to bringing needed investment and growth capital to the environmental industry is to reward continuous environmental improvement.

3.4.2 Full-Cost Accounting

Moving the U.S. economy to better address full-cost accounting and environmental cost accounting issues would also make risks more manageable. Experts and policymakers in the public and private sectors need to be brought together to outline what *changes* are needed in national and corporate accounting practices and what *actions* are necessary to prepare for implementation of these changes. Many organizations—including the Financial Standards Accounting Board, SEC, capital providers, nongovernmental organizations, congressional staff, the Department of the Treasury, and EPA—must participate in the search for solutions.

3.4.3 Government as Buyer

Participation in processes to develop stronger government buying and risk mitigation policies needs to include the General Services Administration, private-sector capital providers, and major agencies that procure environmental products and services. If government were to "behave" better as a buyer and contractor, its contracting and purchasing would be performance based, rather than cost/plus based, and would make use of incentives as well as strictures for failure to perform. Contracting terms must be matched to the length of the sector's capital needs and financial

decision making. (For example, if a private company needs to obtain long-term financing to make capital improvements at a water treatment facility, the contract to manage that infrastructure must be matched in length with the terms of the financing authority.) These steps would also make financial risks more manageable.

3.4.4 Bonuses and Incentives for Early Adopters

Incentives created through fiscal, monetary, and accounting policies could induce capital and management efforts to use new environmentally beneficial technologies. Tax credits, lending, guarantees, preferred government buying, accelerated depreciation, and other vehicles could be used to share risk and create incentives without creating significant impact on the annual federal budget. Energy efficiency, resource recovery, and pollution prevention strategies could also be rewarded through tax incentives and accelerated depreciation. Industry believes that these policies—which are outside the environmental management system but can complement it—could be very cost-effective in the long run, because they too would make risk more manageable.

Within the environmental management system, regulatory bonuses or other incentives would reward companies that are early adopters.

Within the environmental management system, regulatory bonuses or other incentives would stabilize demand for environmental products and services because they would reward companies that are early adopters. Examples of these incentives are expedited permit processes, relief from permit renewal processes, eased compliance audits, and "soft landings" for technologies that minimally fail despite good faith efforts to comply, as discussed earlier.

3.4.5 Small Business Administration (SBA) Assistance

SBA support for small businesses can be a source of financing for the installation and use of environmental products and for the growth of companies developing and selling these products and services. The SBA's Enviro-Bank program could stimulate private environmental investment, increasing the availability of financial resources to the industry and its customers.

3.4.6 Other Risk Management Methods

Three other risk factors could be important to managing investment risks:

- ***Intergovernmental coordination.*** Improved coordination between EPA and the states, as well as among the states, can increase the efficiency of environmental markets by reducing market entry, transaction, and regulatory process costs. Such co-

ordination will help reduce fragmentation in the U.S. market for environmental products and services.

- ***Ombudsman and "one-stop shop" concept.*** Resources that increase transaction efficiency between government regulators and their "customers" facilitate the market function. Heaton and Banks, for example, call for an "EPA Office of Environmental Innovation."[76]

- ***Better systems for collecting and using information.*** Examples available today include systems that provide information on markets and spending, such as the Enviro Statistics Center at EPA and similar electronic systems at DOD and DOE. These information management systems improve market efficiency and help companies manage business risk.

[76] Heaton and Banks, *op. cit.*, page 30.

APPENDIX A

Private-Sector Organizational Responses to Environmental Requirements

Traditional Response

The traditional response predominates. Environmental requirements traditionally have been regarded as a source of extra costs, a drain of productive resources, and the cause of reduced competitiveness with organizations that do not have to meet the requirements. Environmental costs may include consulting fees, the cost of preparing environmental permit applications, environmental permit fees, environmental control equipment for industrial processes, auditing charges, and waste treatment and disposal costs. Funds for environmental investments are carried in separate corporate accounts, and their expenditure uses different criteria (or "hurdle rates") than capital investments that contribute to productive outputs. Environmental and productivity investments must compete for corporate resources. This win-lose perspective generates internal resistance to environmental requirements and compliance processes. End-of-pipe solutions predominate in the traditional response as polluters attempt to collect and treat residuals, rather than avoid their generation. Most companies and industries manage compliance on a site-by-site basis and within site-specific budgetary processes. Even in large organizations, there is little initial centralization of the environmental function, although examples of centralized environmental functions exist today in companies using the traditional approach.

End-of-pipe solutions predominate in the traditional response as polluters attempt to collect and treat residuals, rather than avoid their generation.

Many larger and intermediate-sized companies have established corporatewide environmental organizations, often supporting them with a separate budget for environmental activities. This change facilitates consistent environmental performance from facility to facility and often elevates environmental considerations to the highest level within the company decision-making hierarchy. By elevating environmental decisions to the corporate level, a company can attain a uniformly high rate of regulatory compliance and a favorable environmental image corporatewide. Still, environmental decisions remain separate from decisions about "productive" business activities, and environmental management remains on the "cost" side of company accounts. Further, the environmental costs for a particular product remain separate from the profit-and-loss accounting for that product. In this approach, environmental solutions also tend to be end-of-pipe and to minimize expense from a short-term perspective.

Transitional Response

The search for methods to reduce costs and risks has many origins and has taken many forms. For some companies, intense competition triggered this search. For others, the need to respond quicker in fast-changing markets was the trigger. Still others seek greater internal control over their productive operations, reduced waste, and increased production efficiency. Some have combined the search for ways to improve environmental performance with attempts to develop or adopt methods for enhanced economic performance. Overhanging these new motivators have been the original primary drivers of environmental investment: environmental regulations and public demand for improved environmental performance.

Two major changes in company environmental planning and decision making enable the simultaneous improvement of economic and environmental performance. First, some firms adopt new strategies that decentralize environmental planning and decision making. In these firms, corporatewide environmental compliance organizations are split and their parts assigned to the productive units they serve. Environmental costs are attributed in company accounting to the product or production process from which they arise, rather than being charged to a corporate account, and the benefits from improved manufacturing processes and lower environmental expenses are captured within the business unit.

Second, in the search for competitive advantages, decision making for environmental outcomes is expanded to include more options than in the traditional approach. In particular, transitional firms seek opportunities that reduce waste and the generation of pollution, increase recycling, increase efficiency, and adopt advanced production processes that are economically and environmentally advantageous. To facilitate this change, these companies often integrate environmental and production decision making. As Richard Florida[77] notes, however, sometimes these changes in environmental decision-making processes "may be a consequence of unrelated corporate efforts to improve quality, reduce cost, and/or increase performance rather than from a directed and strategic effort to achieve joint gains in industrial and environmental performance."

The transitional response offers business units the opportunity to benefit from cost savings and, indeed, to seek a wider range of solutions to environmental problems, including those in which environmental problems are avoided and environmental solutions are built into production

The transitional response offers business units the opportunity to benefit from cost savings and to seek a wider range of solutions to environmental problems.

[77] Florida, *op. cit.*, page 97.

processes and product designs. Some of these solutions can increase resource efficiency and productivity, reduce liabilities, improve products, and therefore boost competitiveness. They also allow the environment to be viewed as an opportunity, rather than merely as a cost. Florida found that more than 75% of firms in his large-firm study employ source reduction, recycling, and production process improvements as main elements of their environmental strategies.

If a company integrates environmental management and production functions by changing its organization and its accounting practices, it will be able to recognize that the total cost of a product includes raw materials, labor, capital, and other direct and indirect costs, including all environmental costs attributable to that product.

Advanced Response

If a company changes its organization and its accounting practices, integrating environmental management and production functions, it will be able to recognize that the total cost of a product includes raw materials, labor, capital, and other direct and indirect costs, *including* all environmental costs attributable to that product. This ability to make fine distinctions among product design and production engineering options that are often unseen or undervalued enables companies to gain competitive advantages over competitors practicing the traditional and transitional approaches.

Profound shifts in companies' organizational and decision-making frameworks that result in the inclusion of additional factors and participants in decision making make the advanced response possible. These changes facilitate recognition of beneficial alternatives and enable decisionmakers to choose from among opportunities that can be difficult to find or quantify without the shift. Environmental factors are more fully integrated with other product- and production-specific factors in a business decision process that co-optimizes for environmental outcome and productive performance.

Companies using the advanced approach, like those using the transitional approach, have decentralized environmental planning and decision making. They also seek opportunities to reduce waste and the generation of pollution, increase recycling, increase efficiency, and adopt advanced production processes that are economically and environmentally advantageous. As shown in Florida's work[78] and elsewhere, they distinguish themselves by employing three additional types of critical organizational and technological innovations:

- A more exhaustive exploration of opportunities for environmentally conscious manufacturing (or, more broadly, advanced production process technologies).

[78] Florida, *op. cit.*, pages 95–96.

- Application of advanced production management methods, such as "total quality management" (TQM and its environmental analogue, TQEM).

- Expanded participation in environmental and production decisions to include such key external stakeholder groups as suppliers and customers.

As noted by Florida, firms that employ the advanced approach regard productivity and technology as key elements of manufacturing strategy, devote a relatively high level of capital expenditures to changes in their production processes, and achieve high levels of environmental performance. These firms are usually larger and more technologically sophisticated than a large majority of firms, and they invest in research and development (R&D) at a rate several times higher than average firms.

Firms that employ the advanced approach regard productivity and technology as key elements of manufacturing strategy, devote a relatively high level of capital expenditures to changes in their production processes, and achieve high levels of environmental performance.

TQEM extends the principles of quality management to include manufacturing practices and processes that affect environmental quality. It does this by involving production workers in an ongoing statistical process for improving product quality through incremental gains in both products and processes for both production and environmental management. Firms that employ TQEM and other techniques not only include management, the environmental staff, and production workers in this process, but also design and production engineers, the R&D staff, and staff from other parts of the firm (particularly marketing and finance). Further, the participation of suppliers and customers closes the circle of continuous improvement and market responsiveness.